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CANADIAN THESES ON MICROFICHE

THÈSES CANADIENNES SUR MICROFICHE

NAME OF AUTHOR/*NOM DE L'AUTEUR* Christopher M. Gold

TITLE OF THESIS/*TITRE DE LA THÈSE* Quantitative Methods in the Evaluation of the Quaternary Geology of the Sand River (73L) Map sheet, Alberta, Canada.

UNIVERSITY/*UNIVERSITÉ* University of Alberta

DEGREE FOR WHICH THESIS WAS PRESENTED/ *GRADE POUR LEQUEL CETTE THÈSE FUT PRÉSENTÉE* Ph. D.

YEAR THIS DEGREE CONFERRED/*ANNÉE D'OBTENTION DE CE GRADE* 1978

NAME OF SUPERVISOR/*NOM DU DIRECTEUR DE THÈSE* Ronald W. May

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QUANTITATIVE METHODS IN THE EVALUATION OF THE QUATERNARY GEOLOGY OF THE SAND RIVER (73L) MAP SHEET, ALBERTA, CANADA.

by

© CHRISTOPHER M. GOLD

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH
IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE
OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF GEOLOGY

EDMONTON, ALBERTA

SPRING, 1978

THE UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled "Quantitative Methods in the Evaluation of the Quaternary Geology of the Sand River (73L) Map Sheet, Alberta, Canada." submitted by Christopher M. Gold in partial fulfilment of the requirements for the degree of Doctor of Philosophy.

....
Supervisor

....

Frank W. Stewart
....

....

....
External Examiner

DATE 2nd December 1977

ABSTRACT

The Sand river map sheet, located in east-central Alberta, possesses several bedrock channels buried beneath Quaternary glacial deposits and known only from drill hole information. A total of 995 samples from 78 drill holes were analyzed for 22 compositional properties in an attempt to delineate the stratigraphy of the till units present. The measurements included granulometry, grain lithology, calcium carbonate equivalent and bulk (major and minor element) chemistry. A reliable, rapid, constant -volume carbonate analysis apparatus was developed for the project. Bulk chemistry was performed by fusing till samples into glasses and analyzing them using energy-dispersive electron microprobe techniques. The correction procedures required for quantitative energy-dispersive analysis are described in some detail, along with EDATA, a computer program for applying them. Corrections are applied for atomic number, absorption and fluorescence effects, instrumental calibration corrections, background (X-ray continuum) shaping and fitting as well as peak overlaps.

Problems are often encountered in contour mapping of irregularly spaced data points by computer, and new techniques has been devised and implemented in the TRIMAP package, based on subdividing the map area into triangles. Features include the use of triangular element data structures, a local homogeneous coordinate system, the automatic generation of a triangular network, the selection of a suitable triangle optimization criterion and the choice of a suitable smooth interpolant over individual triangular domains.

Four distinct till units were distinguished in the study area on the basis of their compositions. A high carbonate middle till separates an upper and a two member lower till. The compositional parameters of these tills were categorized as textural, erratic or local. In the fine fraction of a till unit, vertical compositional variation was low by comparison with lateral variation, which appeared to be related to sub-ice topography. The glacial history proposed relates the four suggested ice advances to the varying regional drainage as indicated by the major bedrock channels. The regional topography at each stage was estimated. Compositional analysis of tills, as well as the topographic reconstruction of stratigraphic boundaries, is important in studies of glacial history.

ACKNOWLEDGEMENTS

In a study of this nature, covering a wide variety of topics, it is inevitable that many people have provided advice and assistance. I am greatly indebted to Dr. J.A. Westgate , my original supervisor, for initially suggesting the topic of study, and, upon his departure, to Dr. R.W. May who inherited the unenviable task of continuing what he had not initiated, and without whose advice and encouragement the project would never have been completed. Drs. U.M. Maydell, F.W. Schwartz and G.D. Williams also provided much needed advice on occasion, and their help is greatly appreciated.

Much gratitude is also due to various members of Alberta Environment. Funding for routine laboratory analysis of the drill hole samples was provided by the Research Secretariat of Alberta Environment, and all the samples could not have been analyzed without their assistance and the dedicated help of Mrs. D. Guidera. Mr. H.A. Kerr of the Earth Science and Licensing Division has also been more than generous with his advice, time and patience in promoting and overseeing the laboratory project, as well as making the necessary drill hole samples available. Mr. T. Yoon, Mr. H. Vander Pluym and the field engineers of the Earth Science and Licensing Division have also contributed their time and labour, and I am duly grateful.

In addition to those mentioned above, acknowledgement

must be made of those whose contributions are an integral part of this project. In the work on contour mapping Dr. J. Ramsden of Alberta Research contributed many basic ideas on surface representation, and Mr. T. Charters of Alberta Environment developed some of the key concepts of triangular mesh generation. In the development of the electron microprobe correction procedures, the project was essentially the team work of Dr. D.G.W. Smith and Mr. D.A. Tomlinson of the Department of Geology, University of Alberta, and myself. While it is not possible to specify who thought of what technique in the many discussions spreading over several years, certain broad areas of responsibility can be identified. Dr. Smith's role was primarily to conceive of an analytical approach to the problem of energy dispersive microprobe analysis, identify problems and suggest general approaches to their solution. This is especially true with respect to the physics of X-rays. Mr. Tomlinson was primarily concerned with the implementation of the instrumentation needed for the analytic approach used. My own role has principally been the mathematical and computer - based implementation of the chosen method, as well as contributing to the identification of and definition of problem areas. However, many alternate strategies were attempted in the development of the current procedure, and all team members have been heavily involved in all aspects of their suggestion, evaluation and interpretation.

Finally, I would like to thank Mr. S. Launspach for his assistance with routine microprobe analysis, Dr. Smith for access to the electron microprobe, and my own family for both their assistance in the preparation of the manuscript and their tolerance of the project.

TABLE OF CONTENTS

CHAPTER PAGE

ABSTRACT iv

ACKNOWLEDGEMENTS vi

1.0 INTRODUCTION 1

2.0 STUDY AREA 4
2.1 Location and Data Availability 4
2.2 Topography and Drainage 6
2.3 Previous Work 6

3.0 GENERAL LABORATORY METHODS 9
3.1 Types of Analyses 9
3.2 Sample Examination 9
3.3 Statistical Evaluation of Laboratory Methods 12
3.4 Grain Size Analysis 18
3.5 Lithological Analysis 19
3.6 Carbonate Analysis 20
3.7 Bulk Chemistry 22

4.0 CARBONATE APPARATUS 23
4.1 Analytic Methods 23
4.2 Equipment 24
4.3 Temperature Correction 26
4.4 Calibration 28

5.0 ENERGY DISPERSIVE MICROPROBE ANALYSIS 30
5.1 Principles of Electron Microprobe Analysis 30
5.2 Quantitative Electron Microprobe Analysis 32
5.3 Energy Dispersive Correction Procedures 33
5.4 Instrumental Calibration Corrections 34
5.5 Background Shape 36
5.6 Background Fitting 48
5.7 Peak Overlap 50
5.8 Calculation of Composition 55
5.9 Sequence and Implementation of Correction Procedures 57

6.0 AUTOMATED CONTOUR MAPPING TECHNIQUES 66
6.1 Conventional Contour Mapping Techniques 66
6.2 Triangular Element Data Structures and Coordinates 68
6.3 Data Structure Generation and Optimization 72
6.4 Choice of an Optimization Criterion 76
6.5 Mapping with Triangular Elements 79
6.6 Requirements of an Interpolating Function 81

TABLE OF CONTENTS continued

6.7 Shape Functions 82
6.8 Contour Mapping with the Interpolant 85
6.9 Extension into Higher Dimensions 94

7.0 LABORATORY RESULTS 97
7.1 Differentiation of Till Units 97
7.2 Relation of Analyses to Till Units 100
7.3 Relationships between Analyzed Variables 103
7.4 Choice of Variables for Till Differentiation 112
7.5 Compositional variation within till units 113
7.6 Vertical Variation in Till Composition 114
7.7 Local depositional processes 116
7.8 Lateral Variation in Till Composition 117
7.9 Sampling and Statistical Model 117
7.10 Local Compositional Variation 130

8.0 PREGLACIAL GEOLOGICAL HISTORY 134
8.1 Cretaceous Stratigraphy 134
8.2 Tertiary Stratigraphy 134
8.3 Bedrock Channels and Preglacial Drainage 136

9.0 GLACIAL HISTORY 139
9.1 Lower Member of the Lower Till and Kikino Channel Formation 139
9.2 Deposition of the Upper Member of the Lower Till 144
9.3 Bedrock Thrusts 149
9.4 Middle Till Deposition 154
9.5 Upper Till Deposition 162
9.6 Present Topography 162
9.7 Historical Summary 166
9.8 Correlation of Surficial Units 168

10.0 CONCLUSIONS 172
10.1 Requirements for Stratigraphic Correlation 172
10.2 Choice of Compositional Measurements 172
10.3 Sampling Methodology 173
10.4 Regional Stratigraphy 174
10.5 Hydrology 174
10.6 Analytic and Display Techniques 175

REFERENCES 177

APPENDIX 1 - Formal Laboratory Procedures 186

APPENDIX 2 Calcium carbonate equivalence and grain size analyses for all analyzed samples. 191

APPENDIX 3 Grain lithology and bulk chemical analyses for all analyzed samples. 235

APPENDIX 4 Plots of each drill hole, showing all analyzed variables, lithology and stratigraphic interpretation. 279

TABLE OF CONTENTS continued

APPENDIX 5 Analysis of covariance for each analyzed variable, comparing between - units and within - units variance. 358

APPENDIX 6 Principal components factor analysis of the 22 analyzed variables. 370

APPENDIX 7 Contour maps showing the lateral variation of sand, clay, grain lithology, calcium carbonate equivalent and bulk chemistry in each of the four till units. 374

APPENDIX 8 Between-units versus within-units analysis of variance for each analyzed variable. 439

APPENDIX 9 Analysis of variance for each analyzed variable, comparing variation between areas, till units and vertical positions within till units. 451

LIST OF TABLES

Table	Description	Page
1	Legal locations of drill holes used in this study.	10
2	Results of analyses of test samples used to test laboratory procedures for bulk chemistry, grain size, grain lithology and calcium carbonate equivalence.	13
3	Analyses of variance of the bulk chemistry values of Table 2.	15
4	Analyses of variance of the grain size, grain lithology and calcium carbonate equivalence values of Table 2.	17
5	Overlap coefficients expressed as percentages of measured intensities in analysis peaks of overlapping elements.	53
6	Typical analyses obtained using the EDATA program.	63
7	Comparison of analyses performed by the EDATA program with the best available values.	65
8	Variation of analyses between till units.	102
9	Analyzed variables that differentiate between till units.	104
10	Significance levels of the factors and interactions of Appendix 9.	120
11	Tentative correlation of surficial units between Saskatchewan and Alberta.	170

LIST OF FIGURES

Figure | Page

1 Index map of the study area. 5
2 Drill hole index and generalized topographic map of the study area. 7
3 Construction of carbonate analysis equipment. 25
4 Plots of pressure (x-axis) versus time (y-axis) for several typical materials, using the apparatus of Fig. 3. 29
5 Plots of n versus continuum energy for various operating voltages, obtained from the ratios of copper and diamond spectra. 42
6 Logarithmic plot showing the dependence of g on Eo. 43
7 Plot showing the relationship of c and Eo. 44
8 Plot showing the relationship of f(Eo) to Eo. 45
9 Plots of the ratios of the Z-corrected spectra of assorted metals and oxides with Z-corrected carbon spectra. 47
10 Spectra of various compounds before (upper) and after (lower) continuum and escape peak removal. 51
11 Diagrammatic representation of the overlap coefficients from F to Zn of Table 5. 54
12 Sample EDATA printout for a standard. 56
13 Sample EDATA printout for a sample of unknown composition. 58
14 Schematic flowchart for the EDATA program. 60
15 Triangular element data structures. 69
16 Derivation and use of a local homogeneous coordinate system for a triangle. 70
17 Triangular data structure generation and optimization. 73
18 Rate of convergence of optimization of a triangular mesh. 75
19 Optimization criteria. 77
20 An example of triangulated contour mapping - a magnetic field map. 86
21 Plot of Z = sin(X) sin(Y) 87
22 Bedrock surface elevation in the map area, contoured using gridding and distance - weighted elevations at data points. 88
23 Bedrock surface elevation in the map area, using gridding and distance weighted best - fit planes at data points. 90
24 Bedrock surface elevation in the map area, using automatic triangulation. 91
25 Hand drawn bedrock surface elevation map. 92

LIST OF FIGURES continued

26 Hand generated triangulation of the map area. 93
27 Bedrock surface elevation in the map area, using hand generated triangulation. 95
28 Furthest neighbour dendrogram showing the relationships between the 22 analyzed variables. 106
29 Unweighted pair group dendrogram showing the relationships between the 22 analyzed variables. 107
30 Dendrite analysis dendrogram showing the relationships between the 22 analyzed variables. 108
31 Mode analysis dendrogram showing the relationships between the 22 analyzed variables. 109
32 Plot of factor 2 in till unit 1. 122
33 Plot of factor 2 in till unit 2. 123
34 Plot of factor 2 in till unit 3. 124
35 Plot of factor 2 in till unit 4. 125
36 Plot of erratic / local cation ratio in till unit 1. 126
37 Plot of erratic / local cation ratio in till unit 2. 127
38 Plot of erratic / local cation ratio in till unit 3. 128
39 Plot of erratic / local cation ratio in till unit 4. 129
40 Bedrock geology of the Edmonton - Lac La Biche - Cold Lake area. 135
41 Thickness in feet of unconsolidated deposits immediately underlying till unit 4. 140
42 Elevation in feet of the base of till unit 4. 141
43 Thickness in feet of till unit 4. 142
44 Elevation in feet of the top of till unit 4. 145
45 Thickness in feet of unconsolidated deposits immediately underlying till unit 3. 146
46 Elevation in feet of the base of till unit 3. 147
47 Thickness in feet of till unit 3. 148
48 North - south cross - section through the Vilna bedrock thrust. 151
49 Fence diagram along the bedrock channels of the study area. 153
50 Elevation in feet of the top of till unit 3. 155
51 Thickness in feet of unconsolidated deposits immediately underlying till unit 2. 156
52 Elevation in feet of the base of till unit 2. 157
53 Thickness in feet of till unit 2. 158
54 Elevation in feet of the top of till unit 2. 159
55 Thickness in feet of unconsolidated deposits immediately underlying till unit 1. 160
56 Elevation in feet of the base of till unit 1. 161
57 Thickness in feet of till unit 1. 163
58 Elevation in feet of the top of till unit 1. 164
59 Present surface elevation in feet. 165

1.0 INTRODUCTION

For many years the glacial geology of the Prairies of Western Canada has been known primarily in two dimensions. This was because of the relatively infrequent occurrence of suitable vertical sections. Consequently, although the glacial stratigraphy over much of the Prairies might be expected to be relatively consistent and extensive, little regional information has been available below the uppermost units.

A general exception to this state of affairs has been the work of Christiansen (1968a,b, 1972a,b) utilizing information and samples from holes drilled in the process of regional hydrogeological surveys. He was able to define the regional glacial stratigraphy over much of central Saskatchewan by defining the stratigraphic relationship between drill holes on the basis of electric logs and sample examination. Sauer (1974) mentioned the practical value of till stratigraphy in highway engineering and water supply problems. In particular, where the tills differed in their engineering properties, embankment failure could have been caused by water seepage along inter-till boundaries, and major surficial aquifers were usually located between or below major till layers.

Visual examination of available vertical sections is of great value in conventional field work, but laboratory analyses are often very helpful in the identification of till units. When field examination is restricted to samples taken from a hole during drilling operations, laboratory analysis is necessary to determine criteria for distinguishing superimposed till units.

The primary objective of this study was to examine the regional glacial stratigraphy in an area of Alberta where drill hole samples and data were readily available. The area was also of interest as three bedrock channels were known to be present, and it was hoped that some relationship could be observed between regional glaciation and drainage. It was therefore necessary to determine those compositional properties of greatest value in till identification as well as to determine efficient sampling and analytic strategies for any future work. In the pursuit of these objectives it became necessary to develop new analytic tools. The development of improved apparatus for measuring till carbonate content was one result (see Chapter 4), as was the development, in association with Dr. D. G. W. Smith, of fully quantitative energy dispersive microprobe correction procedures as used in electron microprobe analysis of the bulk chemistry of the fine fraction of till samples (Chapter 5). Finally, in the display of topographic data, grid-type computer contouring algorithms were found to be inadequate because of their inability to resolve features with few sample points, and the difficulty in obtaining a surface that passes precisely through all the data points. A new approach to contour mapping was consequently developed that honoured all data points instead of smoothing the surface, as well as permitting the user-definition of features such as valley-lines.

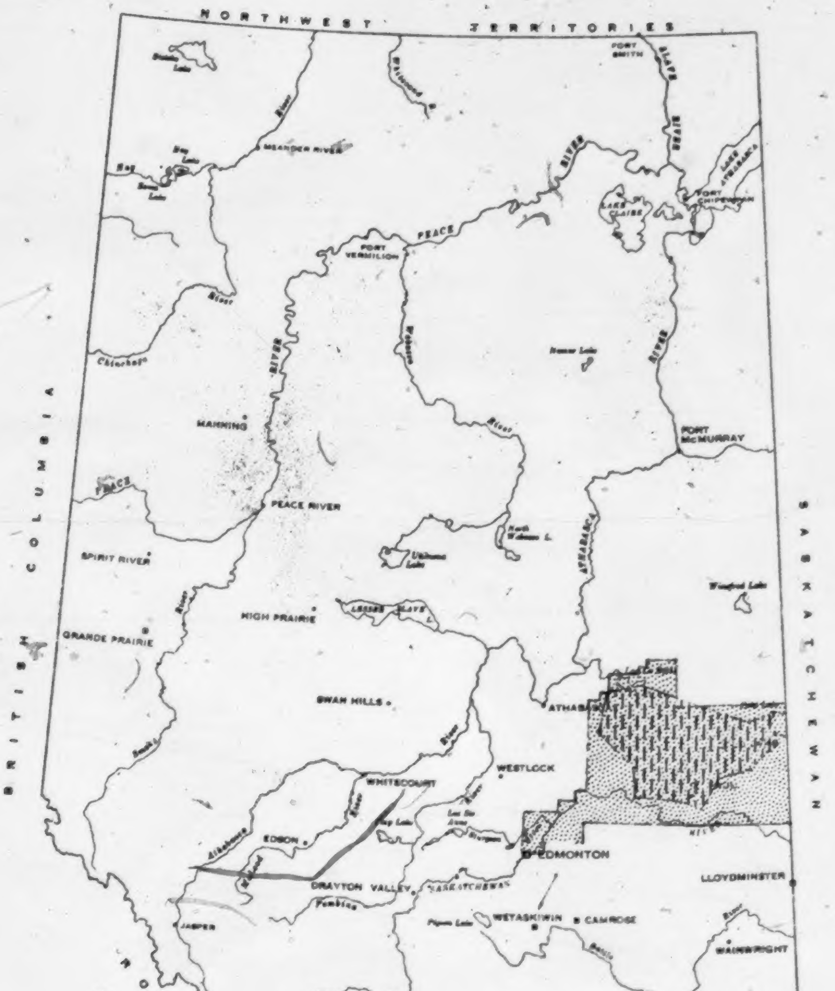
Due to the variety of the subject matter covered, some explanation of the order of presentation may be applicable. After a brief description of the study area, the laboratory methods used in the examination of the drill hole samples are discussed, along with the statistical tests used to evaluate the various analyses. Because the carbonate and microprobe analysis techniques were developed especially for this study,the next two chapters discuss them in detail. In a similar manner, the display and interpretation of the greater than 20,000 analytic results required the availability of suitable display methods, and hence the chapter on contour mapping precedes the detailed examination of laboratory results. Finally, one of the primary purposes of the laboratory analyses is the delineation of the till units found. Thus an interpretation of the glacial history of the area requires in advance both a knowledge of the till units present, as well as some background knowledge of the preglacial history. Historical geology thus represents the synthesis of much previous work.

2.0 STUDY AREA

2.1 Location and Data Availability

In 1974 the Groundwater Branch of Alberta Environment published a report entitled "Buried Channels in the Edmonton - Lac La Biche - Cold Lake Area, Alberta," (Yoon and Vander Pluym, 1974). This was a geological study of three well defined buried bedrock channels: the Beverly, the Kikino and the Helina. Field work in the area included test drilling, lithologic and electric logging, and side-wall sampling of the drilled wells. One hundred and fifty two test holes were drilled, usually to bedrock, with sidewall samples taken from ninety eight of them. Additional well log information was obtained from several other sources, including oil and gas exploration wells.

In this study data were utilized from seventy eight of these drill holes in an area of good sample density and potentially interesting geology where three buried channels were present. All samples from these drill holes were examined and 995 were analyzed in the laboratory. Fig. 1 shows the location of the study area and its relation to the previous report. All drilled holes were located between townships 56 and 68, ranges 2 to 17 west of the fourth meridian. The study area falls mostly within the Sand River (73L) 1:250,000 map sheet of the National Topographic Survey, although a few drill holes are located just to the south (map 73E) or west (83I) of this area.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ROCKY MOUNTAINS
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MEANDER RIVER
FORT CHIPEWYAN
FORT VERMILION
PEACE
MANNING
FORT McMURRAY
PEACE RIVER
SPIRIT RIVER
GRANDE PRAIRIE
HIGH PRAIRIE
LESSER SLAVE L.
SWAN HILLS
ATHABASCA
WESTLOCK
WHITECOURT
EDSON
EDMONTON
LLOYDMINSTER
DRAYTON VALLEY
SASKATCHEWAN
JASPER
WETASKIWIN
CAMROSE
WAINWRIGHT
RED DEER
CORONATION
SUNDRE
DRUMHELLER
BANFF
CALGARY
BROOKS
CLARESHOLM
MEDICINE HAT
LETHBRIDGE
CARDSTON
Alberta
CANADA
1974 study area
This study area

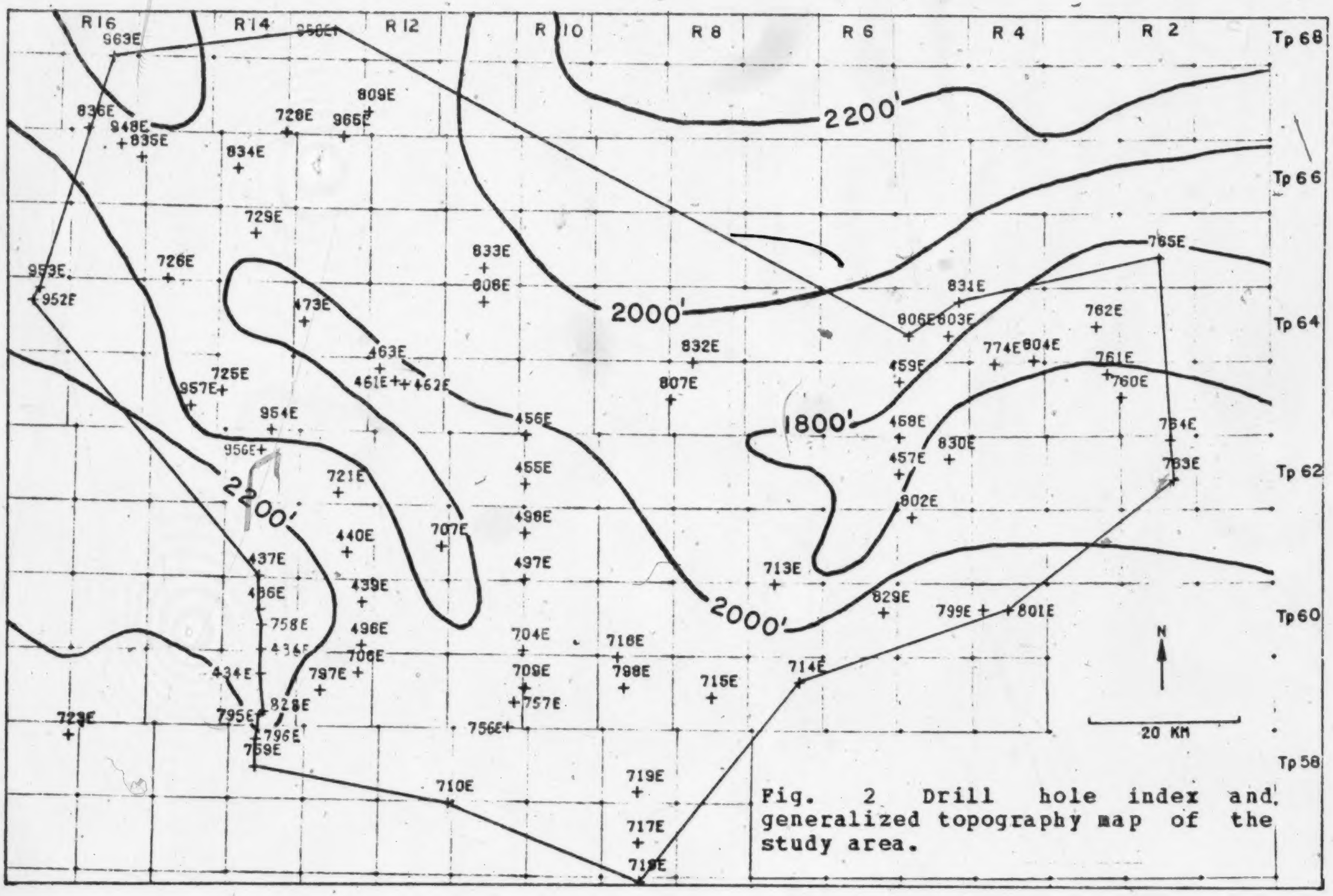
Fig. 1 Index map of the study area.

2.2 Topography and Drainage

The study area is part of the plains region of east-central Alberta. Topography generally rises to 700 metres in the southwest and slopes gently to the north and east. Moderately higher ground is encountered in the northeast corner of the map area. The low points (below 550 m) in the area are around Lac La Biche and between Moose and Cold Lakes. A broad moderately low region connects them (Fig. 2). Three major drainage systems are present in the area, with little in the way of high ground to separate them. The La Biche River drains the low ground in the northwest and is part of the Athabasca and Mackenzie system, flowing into the Beaufort Sea. The Sand and Beaver Rivers drain to the east via Cold Lake and the Churchill River into Hudson Bay at Churchill. The North Saskatchewan River follows a more southerly route and drains into Hudson Bay at York Factory. The area is covered predominantly with ground moraine (having a local relief of less than 3 m) or hummocky moraine possessing more pronounced mounds and depressions.

2.3 Previous Work

Previous work in the area includes the report of Yoon and Vander Pluym (1974) on the buried channels, along with studies of the bedrock topography by Carlson (1967), Lennox and Carlson (1967) and Carlson and Currie (1974). Borneuf (1973) compiled a hydrogeological map of the Tawatinaw map area, which includes the western part of the area of this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836E
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758E
496E
704E
716E
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706E
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797E
709E
798E
715E
714E
828E
757E
795E
723E
796E
756E
759E
710E
719E
717E
718E
N
20 KM

Fig. 2 Drill hole index and generalized topography map of the study area.

study. Le Breton (1963) did the same for east-central Alberta. Bedrock geology has been described by Carrigy (1972) and Green (1972). A hydrogeological map of the map sheet immediately to the east has been produced by Christiansen and Whitaker (1974).

3.0 GENERAL LABORATORY METHODS

3.1 Types of Analyses

Four categories of analysis were performed on each of 995 samples from the map area: grain size analysis, lithological analysis by grain counting, carbonate analysis and bulk (major and minor element) chemistry. Complete details of the laboratory procedures used are found in Appendix 1. A general discussion of each is given below along with a statistical summary. Table 1 gives the legal locations of the 78 drill holes and Appendices 2 and 3 give the results of the analyses performed for all 995 samples. Appendix 4 plots these results beside the electric log for each drill hole for ease of examination.

3.2 Sample Examination

The samples used in this project were obtained from holes drilled, logged and sampled by Alberta Environment staff. While it would have been desirable to obtain more frequent and regularly spaced samples from each hole, drilling schedules, the inability to sidewall-sample coarse-grained material and the occasional cave-in prevented this. Because the sampler may not have penetrated the side of the hole precisely where it was intended it was important that each sample was described in the laboratory prior to processing. Comparison with the driller's and electric logs identified any mis-located samples. Because, for example,

Hole #	LSD-SEC-TP-RG-W4M	Hole #	LSD-SEC-TP-RG-W4M	Hole #	LSD-SEC-TP-RG-W4M
434E	LSD 1-28-59-14-W4	717E	LSD 13-15-57-9-W4	803E	LSD 3-14-64-5-W4
435E	LSD 1-4-60-14-W4	718E	LSD 12-34-56-9-W4	804E	LSD 4-1-64-4-W4
436E	LSD 8-21-60-14-W4	719E	LSD 16-4-58-9-W4	806E	LSD 4-17-64-5-W4
437E	LSD 1-4-61-14-W4	721E	LSD 13-3-62-13-W4	807E	LSD 13-18-63-8-W4
439E	SW 25-60-13-W4	723E	LSD 13-25-58-17-W4	808E	LSD 12-27-64-11-W4
440E	SE 15-61-13-W4	725E	LSD 3-19-63-14-W4	809E	LSD 14-7-67-12-W4
455E	LSD 13-7-62-10-W4	726E	LSD 1-5-65-15-W4	828E	LSD 3-10-59-14-W4
456E	LSD 13-31-62-10-W4	728E	LSD 1-1-67-14-W4	829E	LSD 9-23-60-6-W4
457E	NW 18-62-5-W4	729E	LSD 16-21-65-14-W4	830E	LSD 4-36-62-5-W4
458E	LSD 13-31-62-5-W4	756E	LSD 1-2-59-11-W4	831E	LSD 13-25-64-5-W4
459E	LSD 4-30-63-5-W4	757E	LSD 3-13-59-11-W4	832E	LSD 16-32-63-8-W4
461E	NW 22-63-12-W4	758E	LSD 1-16-60-14-W4	833E	LSD 5-10-65-11-W4
462E	NE 21-63-12-W4	759E	LSD 12-16-58-14-W4	834E	LSD 3-20-66-14-W4
463E	NW 31-63-12-W4	760E	LSD 4-15-63-2-W4	835E	LSD 15-24-66-16-W4
473E	NE 13-64-14-W4	761E	LSD 4-36-63-3-W4	836E	LSD 4-4-67-16-W4
496E	LSD 7-1-60-13-W4	762E	LSD 13-14-64-3-W4	948E	LSD 4-35-66-16-W4
497E	LSD 4-6-61-10-W4	763E	LSD 5-14-62-2-W4	952E	LSD 4-27-64-17-W4
498E	LSD 13-19-61-10-W4	764E	NE 34-62-2-W4	953E	LSD 2-34-64-17-W4
704E	LSD 4-6-60-10-W4	765E	LSD 5-15-65-2-W4	954E	LSD 13-34-62-14-W4
706E	LSD 8-26-59-13-W4	774E	LSD 16-32-63-4-W4	956E	LSD 13-15-62-14-W4
707E	LSD 11-13-61-12-W4	795E	LSD 13-3-59-14-W4	957E	LSD 16-10-63-15-W4
709E	LSD 5-19-59-10-W4	796E	LSD 13-28-58-14-W4	958E	LSD 7-15-68-13-W4
710E	LSD 15-36-57-12-W4	797E	LSD 16-17-59-13-W4	963E	LSD 13-35-67-16-W4
713E	LSD 13-33-60-7-W4	798E	LSD 5-21-59-9-W4	965E	LSD 3-2-67-13-W4
714E	LSD 13-23-59-7-W4	799E	LSD 16-19-60-4-W4		
715E	LSD 1-16-59-8-W4	801E	LSD 16-21-60-4-W4		
716E	LSD 15-32-58-9-W4	802E	LSD 5-32-61-5-W4		

Table 1 Legal locations of drill holes used in this study.

some tills, lake deposits and shales may be composed of very similar materials it was of considerable importance that those structural features that could distinguish them were described prior to sample crushing. Only those samples considered to be till were analyzed further.

The term till may have at least two meanings. In the broad sense it includes any material deposited by glacial ice, and in this context extensive thicknesses of bedrock material that have been interpreted as having been moved by the ice have been classified in this study as part of a particular till unit. Dreimanis (1976) discusses deformed bedrock and block inclusions in till. In a more limited sense, till is considered to be a material posessing a characteristically wide range of grain sizes that has been deposited directly from glacial ice. Goldthwait (1971) discusses till as a fairly homogeneous material of mixed particle sizes. It was in this sense that individual drill hole samples were classified as till. While the first of these two properties was readily observable in a small sample, the requirement that it be ice deposited was less readily ascertained than would have been the case for exposed geological sections. Consequently there is a very real probability that some other diamicton was misclassified as till, the most likely candidate being till material that was re-mobilized in some manner, and hence was no longer strictly till. However, this problem has been reduced to some extent by the scale chosen for the current study. Unlike the examination of a single exposed section, lithologic units much less than 5m thick are often difficult to resolve, due both to the vertical sample spacing and the distance between drill holes. Thus thin diamictons interspersed with water-laid deposits would usually be assigned to a "mixed" category in the log of a drill hole, a not unreasonable classification for a regional-scale study. Thus only extensive thick diamictons would be likely to be stratigraphically considered tills, an interpretation that would probably be correct.

3.3 Statistical Evaluation of Laboratory Methods

Laboratory methods were evaluated by analyzing a set of arbitrarily chosen test samples. The results of these analyses are given in Table 2. For the grain size, grain count and carbonate analyses, measurements were taken several times on each of several samples, using different sub-samples of each test sample to produce the replicate analyses of Table 2. In the case of bulk chemistry, an additional step - the preparation of a fused glass of the sample - was needed. Several glasses were made from each test sample and bulk chemical analysis was performed twice on each glass using the electron microprobe. May and Dreimanis (1976) suggest a variability model in which an observation is the sum of the population mean and the natural, sampling, preparation, analytical and random variabilities. Variation between the different analyses for

Sample Glass Analysis	A 1 1	A 1 2	A 2 1	A 2 2	A 3 1	A 3 2	A 4 1	A 4 2	B 1 1	B 1 2	B 2 1	B 2 2	B 3 1	B 3 2	B 4 1	A 4 2	A V G
Na	0.266	0.0	0.0	0.0	0.135	0.0	0.0	0.088	0.248	0.125	0.201	0.0	0.0	0.268	0.0	0.290	.191
Mg	0.641	0.815	0.640	0.662	0.796	0.730	0.847	0.717	0.693	0.779	0.774	0.696	0.801	0.749	0.747	0.713	.738
Al	7.701	7.741	7.626	7.543	7.811	7.607	7.658	7.719	7.839	7.722	7.771	7.540	7.708	7.588	7.852	7.546	7.705
Si	33.434	33.792	34.375	34.278	33.633	34.228	34.051	33.831	33.573	33.733	33.751	34.272	33.823	33.014	33.577	33.632	33.851
K	[illegible]	[illegible].686	1.929	1.855	1.921	1.908	1.925	1.933	2.044	1.905	1.883	1.899	1.890	1.422	1.901	1.873	1.909
Ca	[illegible]	2.121	1.850	1.989	2.137	1.919	2.009	2.165	2.010	2.069	2.044	1.906	1.959	2.162	2.092	1.947	2.0[illegible]
Ti	0.305	0.503	0.427	0.463	0.556	0.476	0.486	0.429	0.500	0.498	0.525	0.496	0.449	0.453	0.444	0.451	.471
Fe	3.999	3.993	3.748	3.907	4.031	3.928	3.875	4.106	4.188	4.180	4.027	3.876	4.068	4.258	4.265	4.138	4.037

Sample Replicate	C 1	C 2	D 1	D 2	E 1	E 2	F 1	F 2	G 1	G 2	A V G
10-20	5.14	6.05	4.72	4.53	4.67	3.35	3.13	3.28	3.28	3.23	4.11
20-40	4.86	5.69	7.03	7.67	7.58	5.40	4.56	5.11	4.52	4.82	5.72
40-60	7.84	10.13	9.95	8.70	8.09	10.57	10.21	10.42	7.40	7.62	9.09
60-140	13.63	10.66	14.02	11.64	22.11	14.46	11.66	12.34	11.77	10.45	13.28
140-230	5.69	4.86	6.36	5.81	0.61	6.26	4.43	6.42	6.18	6.58	5.87
Silt	50.14	50.32	48.91	53.85	49.23	51.21	55.32	52.45	53.50	54.60	51.96
Clay	12.70	12.30	9.01	7.89	7.70	8.75	10.19	9.93	13.26	12.71	10.44

Sample Replicate	H 1	H 2	H 3	H 4	H 5	I 1	I 2	I 3	I 4	I 5	A V G
Local	12.0	15.0	19.0	20.5	18.5	13.5	11.0	12.5	8.0	8.5	13.85
Acid	69.0	72.5	67.0	65.5	63.5	70.5	72.5	69.5	73.0	70.0	69.30
Basic	5.5	2.0	2.0	2.0	3.0	1.0	1.0	1.5	0.5	1.5	2.00
Carb	1.0	0.5	1.0	1.0	0.5	3.0	4.0	4.5	2.5	2.5	2.05
Qtz.	12.5	10.0	11.0	11.0	14.5	12.0	11.5	13.5	16.0	17.5	12.95

Sample Replicate	J 1	J 2	J 3	J 4	K 1	K 2	K 3	K 4	L 1	L 2	L 3	L 4	A V G
$CaCo_3$ Equis.	2.3	2.4	2.6	2.5	4.3	4.6	4.3	4.5	4.6	4.5	5.0	5.0	4.67

Table 2 Results of analyses of test samples used to test laboratory procedures for bulk chemistry, grain size, grain lithology and calcium carbonate equivalence.

the bulk chemical analysis may therefore be due to real variation between the samples analyzed (natural plus sampling variability, or between-sample variance in this example), to compositional variation between material taken from the sample to make each glass (preparation variability or sub-sample variance) or to variation between individual measurements on each glass (analytical plus random variation, or error variance). It should be noted that it was not known in advance whether a particular set of samples could be expected to differ significantly in all the analyses performed on it, although a different choice of samples might well have shown such a difference. Thus the ability to distinguish samples in the test set is of less interest than the standard deviation of the within-samples (or between glasses, within-samples) variance. Analysis of variance techniques were used to examine the various components of the variation in laboratory analyses on the test samples.In the case of the bulk chemistry, two arbitrary samples, A and B, each had 4 glasses (sub-samples) made from them. Two analyses were performed on each glass. The analysis of variance model is a one way classification with equal sub-sample numbers (Steel and Torrie, 1960, Section 7.11). The analyses are given in Table 3. The within sample variance may be ascribed to both variation between glasses made from the same sample and variation in multiple analyses of each glass; hence two F tests may be made, comparing variation between samples with variation between

Variable	Source of Variation	df	Sum of Square	Mean Square	F	Standard Error of Mean	Standard Deviation	Coefficient of Variation
Na	Between Samples	2	0.025341	0.02584	5.96			
	Between glasses in samples	2	0.026021	0.00434		.0233	.0659	63%
	Between glasses	7	0.051862		0.23			
	Within glasses	8	0.154093	0.01926				
	Total	15	0.205951					
Mg	Between Samples	1	0.000676	0.000676				
	Between glasses in samples	6	0.022672	0.00378	0.18	.0217	.0615	6%
	Between glasses	7	0.023348		0.87			
	Within glasses	8	0.034678	0.00433				
	Total	15	0.058026					
Al	Between Samples	1	0.013225	0.01323	0.98			
	Between glasses in samples	6	0.081171	0.01353		.0411	.1163	2%
	Between glasses	7	0.094396		1.60			
	Within glasses	8	0.067656	0.00845				
	Total	15	0.162052					
Si	Between Samples	1	0.288101	0.28810	3.71			
	Between glasses in samples	6	0.465334	0.07756		.0985	.2785	1%
	Between glasses	7	0.753434		1.60			
	Within glasses	8	0.387873	0.04848				
	Total	15						
K	Between Samples	1	0.000495	0.000495	0.228			
	Between glasses in samples	6	0.013018	0.00217		.0165	.0466	2%
	Between glasses	7	0.013513		1.26			
	Within glasses	8	0.013768	0.00172				
	Total	15	0.027281					
Ca	Between Samples	1	0.001040	0.00104	0.123			
	Between glasses in samples	6	0.050773	0.00846		.0325	.0920	5%
	Between glasses	7	0.051813		0.864			
	Within glasses	8	0.078330	0.00979				
	Total	15	0.13043					
Ti	Between Samples	1	0.00063768	0.000638	0.343			
	Between glasses in samples	6	0.0111509	0.00186		.0152	.0431	9%
	Between glasses	7	0.0117864		1.31			
	Within glasses	8	0.0113915	0.00142				
	Total	15	0.0231779					
Fe	Between Samples	1	0.124786	0.12479	6.19			
	Between glasses in samples	6	0.121003	0.02017		.0502	.1420	4%
	Between glasses	7	0.245789		1.46			
	Within glasses	8	0.082191	0.01827				
	Total	15	0.327979					

Table 3 Analyses of variance of the bulk chemistry values of Table 2.

glasses, and comparing between glasses and within glasses variance. In the second case significant differences between glasses for the same sample were not found, showing that glass preparation was not a significant source of error.

Table 4 gives the analysis of variance for the grain size, grain count and carbonate analysis. The model is a one-way classification with equal replication (Steel and Torrie, 1960, Section 7.3). Since only one analysis is performed on each sub-sample, the within-sample variance is a combination of sampling and error variance. Duplicate analyses are not performed on each sub-sample in carbonate analysis because the method destroys the material used. For grain counts, analytic error is only found if the operator classifies a grain differently on two different passes, a relatively infrequent occurrence. In addition, the small number of suitable 1-2mm sand grains present in a sample necessitate recombining the analyzed sub-sample with the test sample prior to selecting a further 200 grains for analysis. While it may be possible to perform grain size analysis several times on each sub-sample this was judged to be technically awkward, especially for the silt and clay fractions.

Details of which particular compositional variables differ significantly between test samples are given in the relevant sections below.

Variable	Source of Variation	df	Sum of Square	Mean Square	F	Standard Error of Mean	Standard Deviation	Coefficient of Variation
Size 10-20	Between Samples	4	8.0532	2.0133	7.65	0.363	.513	12%
	Within Samples	5	1.3158	0.2632				
	TOTAL	9	9.3690					
Size	Between Samples	4	10.6669	2.6667	4.27	.559	.790	14%
	Within Samples	5	3.1217	0.6243				
	TOTAL	9	13.7556					
Size 40-60	Between Samples	4	5.2417	2.0604	1.58	.808	1.142	13%
	Within Samples	5	6.5247	1.3049				
	TOTAL	9	14.7664					
Size 60-140	Between Samples	4	65.6494	16.4124	2.18	1.940	2.744	21%
	Within Samples	5	37.6415	7.5283				
	TOTAL	9	103.2909					
Size 140-230	Between Samples	4	10.7552	2.6888	0.76	1.328	1,879	35%
	Within Samples	5	17.6470	3.5294				
	TOTAL	9	28.4022					
Silt Size	Between Samples	4	29.2415	7.3104	1.94	1.371	1.939	4%
	Within Samples	5	18.8067	3.7613				
	TOTAL	9	48.0482					
Clay Size	Between Samples	4	39.8247	9.9562	32.15	.394	.557	5%
	Within Samples	5	1.5484	0.3097				
	TOTAL	9	41.3731					
Local Grains	Between Samples	1	99.225	99.225	11.21	1.330	2.975	21%
	Within Samples	8	70.800	5.850				
	TOTAL	9	170.025					
Acid Grains	Between Samples	1	32.40	32.40	4.531	1.196	2.674	4%
	Within Samples	8	57.20	7.150				
	TOTAL	9	89.60					
Basic Grains	Between Samples	1	8.10	8.10	6.545	.498	1.113	56%
	Within Samples	8	9.90	1.238				
	TOTAL	9	18.00					
Carbonate Grains	Between Samples	1	15.625	15.625	2.372	1.148	2.567	125%
	Within Samples	8	3.60	6.588				
	TOTAL	9	19.225					
Undifferentiated Quartz	Between Samples	1	13.225	13.225	2.713	2.713	2.180	17%
	Within Samples	8	39.00	4.875		.975		
	TOTAL	9	52.225					
Ca CO_3 Equiv.	Between Samples	2	12.7517	6.3759	152.00	.102	.205	4%
	Within Samples	9	0.3775	0.0419				
	TOTAL	11	13.1292					

Table 4 Analyses of variance of the grain size, grain lithology and calcium carbonate equivalence values of Table 2.

3.4 Grain Size Analysis

Material from the lightly crushed sample that did not pass through a U.S. standard #230 sieve (0.063 mm) by dry-sieving was washed, dried and sieved through #10 (2 mm), #20 (1 mm), #40 (0.5 mm), #60 (0.25 mm), #140 (0.125 mm) and #230 size sieves. Dry material initially passing through the #230 sieve therefore consisted of silt and clay, and pipette analysis was used to determine the clay content (see Day, 1965). The pipette method was chosen over the hydrometer method due to the reduced labour involved. In the former once particle settling has commenced a single measurement is required after the calculated settling time, whereas in the latter method readings must be taken at systematic intervals, severely limiting the number of samples that may be analyzed at one time. In addition, the pipette method is more readily usable on smaller samples than the hydrometer method. Material between 2mm and 0.063 mm was considered to be sand, between 0.063 and 0.002mm silt and below 0.002mm clay.

In the analysis of variance tests described earlier the test samples could be distinguished by the weight percentages of the 1-2 mm. size fraction at the 95% level, the 0.5 - 1 mm. fraction at the 90% level and the clay fraction at the 95% level. The intermediate size ranges did not differ significantly between the test samples. Although well able to distinguish the test samples, the absolute clay percentages must be suspect due to the long storage times and consequent disaggregation problems associated with the sidewall samples used (see Appendix 1). Pawluk and Bayrock (1969), for example, found an average of 30% clay (less than 2 micron material) for 20 samples from widely spaced locations in the Sand River map sheet, markedly higher than the 10% observed in the present work. Nevertheless the coarse sand and clay fractions appear to be of use in sample differentiation due to their significant F tests mentioned above. It should be noted that the non-standard granulometric methods described above were implemented due to both the large number and small sizes of the available samples.

3.5 Lithological Analysis

Lithological analysis is commonly used in attempts to distinguish between till sheets.Some results from the Edmonton area are quoted in Westgate *et al.* (1976). His results were obtained by counting boulders in the field or pebbles in the laboratory. Because the size of sidewall samples precluded the use of these size fractions, the 1 - 2 mm sand fraction was used instead. Dreimanis and Vagners (1969,1971) discuss the use of differing size fractions for examining the variation in lithology in a till, and Willman *et al.* (1963) use the mineralogy of the sand sizes to distinguish between till sheets. They concluded that sand lithology may successfully distinguish till sheets, but care must be taken not to confuse measurements obtained in one area using one size fraction with results obtained elsewhere using a different size fraction.

The method used involved the classification of 200 grains from each sample into five categories: local shales and sandstones, acid igneous rocks, basic igneous rocks, carbonate rocks and undifferentiated quartz grains. Five to six samples could be analyzed per hour if interspersed with work less tiring to the eyes. The test samples could be distinguished at the 95% confidence level by the local and carbonate rocks and at the 90% level by the acid and basic igneous rocks (Table 4). As shown by the fairly high coefficient of variation for the basic and carbonate grains, the number of counts observed were rather low for assumptions about the normal distribution of the results to be certain. Statistics based on these two measurements should therefore be treated with caution.

3.6 Carbonate Analysis

Among the rock types that were probably traversed by the glacial ice are the limestone and dolomite found in the belt of Devonian rocks fringing the Precambrian shield to the north and east of the map area (Douglas, 1968 and Green, 1972). Rather than counting sand grains to determine the lithology of the parent rocks, however, the content of carbonate rocks is readily determined by mixing the till with hydrochloric acid and determining the amount of carbon dioxide evolved. Dreimanis (1962) and Dreimanis and Vagners

(1969, 1971) used this method to determine calcite and dolomite content of tills in Ontario. Christiansen (1968a,b, 1972a,b) used the same approach to measure the total carbonate content of tills in Saskatchewan. Along with other workers they measured the volume of gas at constant pressure. Dreimanis and Vagners used a manually balanced glass manometer, while Christiansen and Ross (1971) used electro-mechanical equipment of their own design. The advent of relatively inexpensive solid-state pressure sensors permitted the development of a constant-volume device that is inexpensive, reliable and permits rapid analysis even when used by unskilled operators (see Chapter 4). In some parts of North America limestone and dolomite can be distinguished on the basis of their rates of solution, (Dreimanis, 1962). This has also been attempted in Alberta (Westgate,1972). The current work, however, suggests that this distinction is not easily made and like Christiansen (1972b), only total carbonate or total carbon dioxide evolved should be used, at least in central Alberta. Statistical tests using total carbonate gave excellent sample differentiation in the test analyses. The between-samples variance was significantly greater than the within-samples variance at better than the 99% level (Table 4). Further details of the equipment are given in Chapter 4.

3.7 Bulk Chemistry

Bulk chemistry of the silt and clay fraction of till is potentially as useful as carbonate analysis for stratigraphic correlation. May and Dreimanis (1973) have separated tills in southern Ontario on the basis of trace element analysis, and Pawluk and Bayrock (1969) analyzed Alberta tills for some trace elements, but little work has been done on the major and minor rock-forming elements. Energy dispersive analysis on an electron microprobe was used to analyze the till samples for 22 elements simultaneously, 8 of which occurred within the detection limits of the method. Details of the methods developed are given in Chapter 5. Sample fractions passing through a #230 sieve were fused into glasses using the techniques of Schimann and Smith (1976) and analyzed in the microprobe. Raw data were processed using the procedure described in Gold and Smith (1976). With the exception of Na, errors due to preparation of glasses were unimportant on the statistical test data. The samples could be distinguished by Na at the 90% and Fe at the 95% confidence levels, but the Na results were considered suspect because of the high coefficient of variability (Table 3) and the raw analysis values being close to the detection limit for that element. Due to the closeness of their analytic peaks and the low intensities observed it is possible that the Ti figures also include minor amounts of Ba.

4.0 CARBONATE APPARATUS

4.1 Analytic Methods

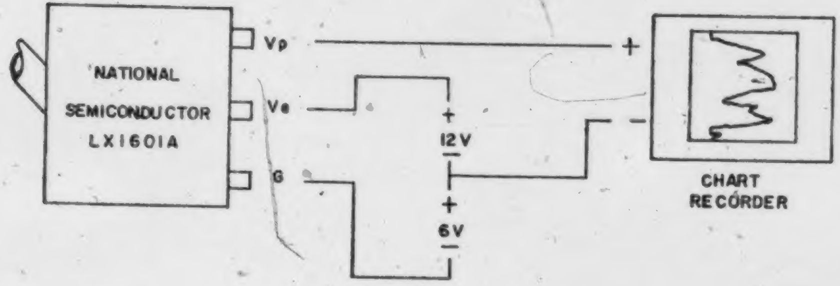
The normal method of determining the carbonate content of a soil or till sample requires that the carbon dioxide, generated by reaction with dilute (20%) HCl, be measured by the change in volume at constant (atmospheric) pressure. This is usually done by manually balancing the pressure on either side of a U-tube (Dreimanis, 1962). Other work, attempting to relate the rate of solution to the carbonate composition and grain size, has been done by Skinner and Halstead (1958), Skinner *et al.* (1959), Turner (1960) and Turner and Skinner (1960). Small negative pressures should always be maintained except when readings are being taken, in order to reduce the chances of leakage. Temperature corrections applied using the gas law, PV = nRT are usually only applied to the generated gas volume, and ignore the expansion of the dead air in the system, which can cause errors of the same order of magnitude as the measured reading. This is important since the initial heat of reaction is dissipated through the glass walls of the flask in the course of the analysis. Manual reading of volumes is difficult, especially when they must be taken at short time intervals. More elaborate constant-pressure electromechanical devices have been developed (Dyck and Perkins, 1974).

4.2 Equipment

The equipment developed here detects the carbon dioxide evolved by monitoring the pressure change inside a system of constant volume. If pressures are kept low (a few p.s.i.) the effect of pressure variation on the reaction or the solubility of carbon dioxide in the acid will be minimized. The pressure is monitored by a small recently-developed solid-state detector from National Semiconductor and the output fed directly to any chart recorder (Fig. 3a). The detector's sensitivity is much greater than is required for this apparatus. Use of a chart recorder permits use of a stronger acid, usually 50%, and hence a more rapid reaction, easy observation of the end of the reaction and of any errors such as a leak in the flask seal or a slow stirrer. Analysis of typical till samples showed no additional gas evolution for acid concentrations between 20% and 75%, suggesting that for samples used in this study solution of other than carbonate compounds was not a problem. It should be noted that in other areas the use of high acid concentrations may result in the solution of till constituents (e.g. sulphides) not noted in this study.

The detector is connected to an acrylic flask with a screw-down sealing cap and an internal acid reservoir (Fig. 3b). A 1.00 ± 0.005 gm sample and a magnetic stirrer are placed in the flask, the cap screwed down, the flask tilted to mix the acid and sample and then placed on the stirrer. The screw cap minimizes the chances of leakage (which is

a) ELECTRICAL CIRCUIT FOR CARBONATE APPARATUS


NATIONAL
SEMICONDUCTOR
LX1601A
Vp
Vs
G
+
12V
−
+
6V
−
+
−
CHART
RECORDER

b) SAMPLE FLASK FOR CARBONATE APPARATUS

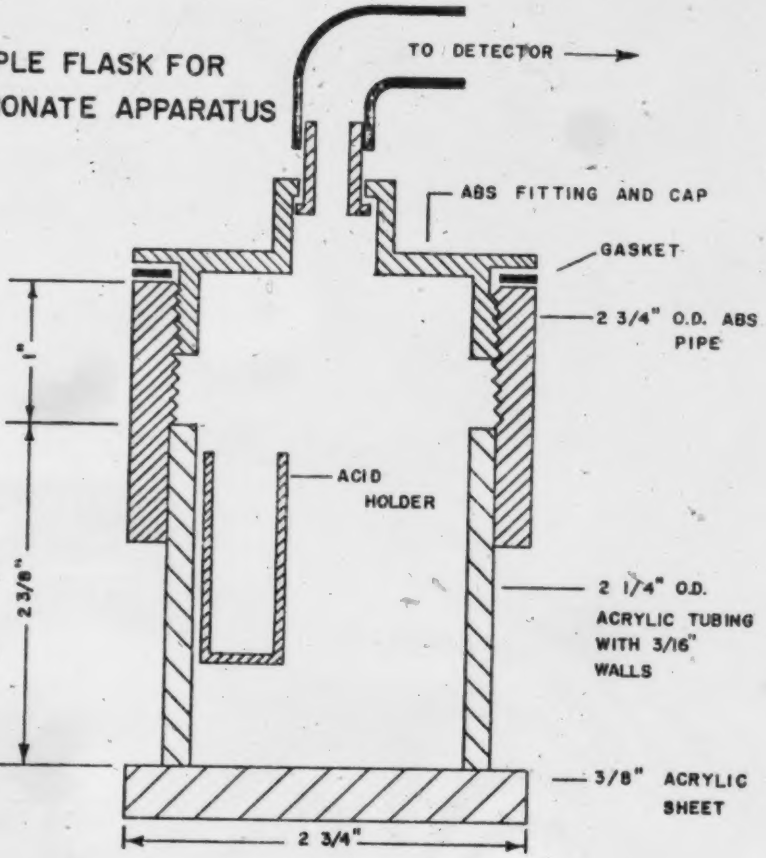

TO DETECTOR
ABS FITTING AND CAP
GASKET
2 3/4" O.D. ABS PIPE
1"
ACID HOLDER
2 3/8"
2 1/4" O.D. ACRYLIC TUBING WITH 3/16" WALLS
3/8" ACRYLIC SHEET
2 3/4"

Fig. 3 Construction of carbonate analysis equipment.

rapidly noticed if the cap is not screwed tight enough). With two sets of equipment and spare flasks at least eight samples may be run in an hour, frequently more if the dolomite content is low. Since the equipment is battery operated and portable it may be used in the field if manual agitation and a volt-meter are used instead of the magnetic stirrer and chart recorder, which both require a 110-volt power.

4.3 Temperature Correction

Pyrex glass has a thermal conductivity of 26 calories per second per square cm for a one degree celsius per cm thermal gradient. In the same units acrylic has a thermal conductivity of 4 - 6. Thus as the acrylic flask is a much better insulator than glass the heat of the reaction is retained in the flask with very little loss during the duration of the run. This is supported by the fact that, using the acrylic flask, no pressure drop has been noted for at least 30 minutes after the reaction has ceased. Conversely, with the acrylic flask external temperature changes during a run are of little concern. Magnetic stirrer or hand warmth is capable of penetrating glass, as was readily observed while monitoring pressure changes in a glass flask. For small changes in temperature and pressure the heat of reaction is approximately proportional to the carbonate content of the sample, i.e.

$$[4.1] \quad T_f = T_i + k\ M_c,$$

where M_c is the mass of carbon dioxide generated and T_f and T_i are the final and initial temperatures of the system. Since the volume V of the system is constant, as is M_a, the mass of dead air in the system, the ideal gas law gives the initial pressure of the dead air in the system as

[4.2] $P_a = R\ T_i\ M_a\ /\ V$,

the final partial pressure due to generated carbon dioxide as

[4.3] $P_c = R\ T_f\ M_c\ /\ V$

and the final partial pressure due to the dead air in the system as

[4.4] $P_e = R\ T_f\ M_a\ /\ V$,

R being the gas constant. Substituting for T_f and simplifying, the final pressure difference

[4.5] $P_d = P_c + P_e - P_a$

$= R\ M_c\ (\ T_i + k\ (\ M_c + M_a\ ))\ /\ V$.

Thus if the mass of carbon dioxide is a small fraction of the dead air mass the quadratic term can be ignored and pressure change considered proportional to carbon dioxide, and hence carbonate, mass. In most laboratories the dependence on initial atmospheric temperature and pressure can be adequately compensated for by regular calibration with reagent grade calcium carbonate. As shown in Christiansen and Ross (1971) and Perkins and Dyck (1973) it is important that stirring speed be standardized.

4.4 Calibration

Calibration of the apparatus is direct and analyses for calcium carbonate equivalent may be calibrated easily by running a standard of known calcium carbonate composition every few hours, the pressure being nearly proportional to the carbonate content, as shown above. The standard error of analysis is 0.2% (see Table 4), and is partially dependent on the recording device used and the accuracy of sample weighing. The detection limit is visually estimated as 0.2%. Distinction of calcite from dolomite content due to the break in slope of their curve due to their differing solubilities does not appear to be feasible in the test area since the local limestone may take two or three minutes to dissolve (see Fig. 4), as opposed to the less than one minute quoted for limestone in other regions (Dreimanis, 1962). While this may be due to partial dolomitization of the limestone samples, no break in slope was readily apparent in till sample analysis curves. For simplicity of calibration all figures are quoted as calcium carbonate equivalent.

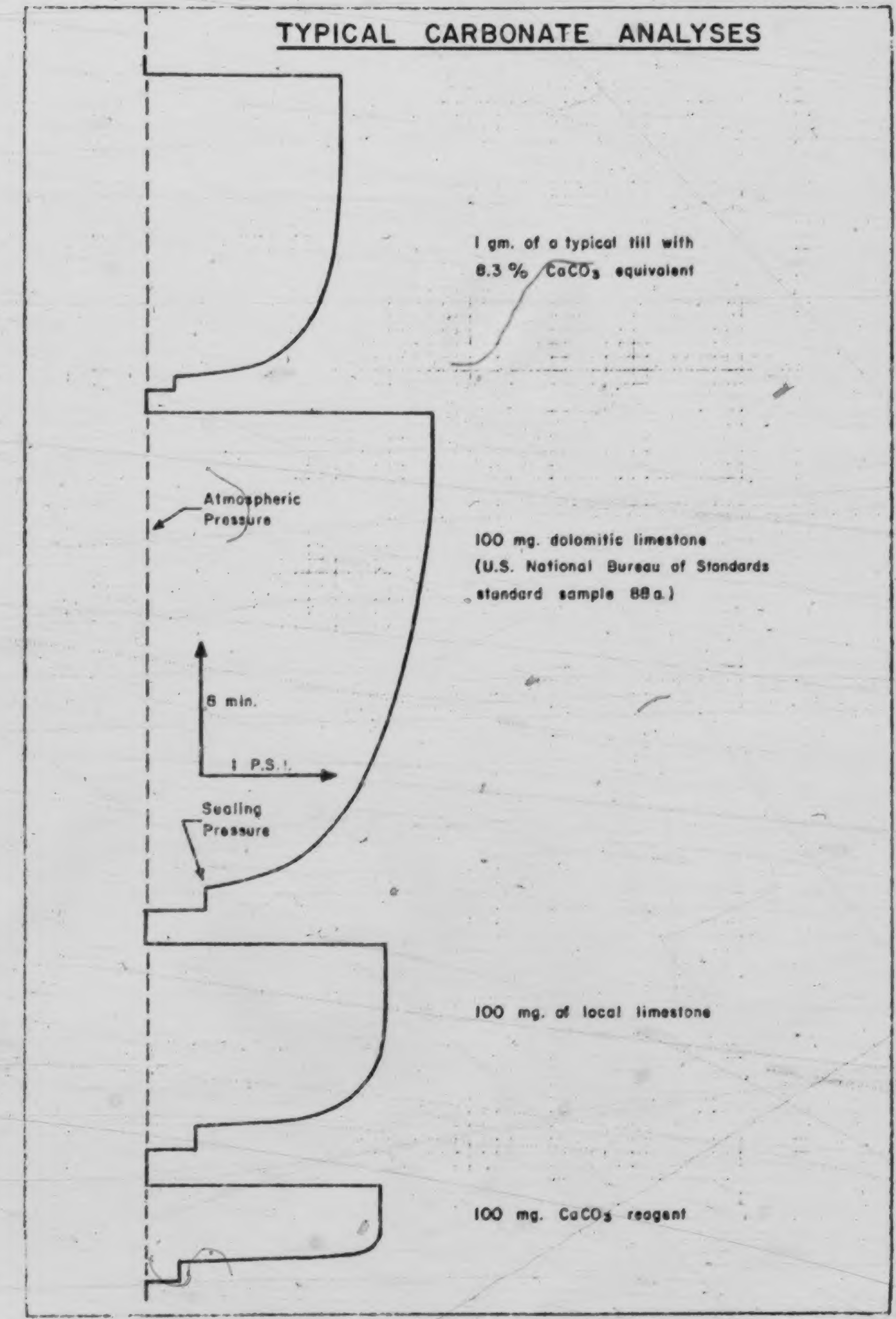


Fig. 4 Plots of pressure (x-axis) versus time (y-axis) for several typical materials, using the apparatus of Fig. 3.

5.0 ENERGY DISPERSIVE MICROPROBE ANALYSIS

5.1 Principles of Electron Microprobe Analysis

In an electron microprobe, a beam of electrons is focussed on a polished specimen in order to excite the atoms of the sample and produce the characteristic X-ray spectra of elements present. Ignoring various factors such as loss by absorption, the intensity of any particular X-ray line of any element is proportional to the concentration of the element in the sample. Thus if a standard and a specimen are analyzed under the same conditions:

$$[5.1] \quad C_{sp} = C_{st} * I_{sp}/I_{st}$$

where C_{sp} and C_{st} are the concentrations in the specimen and standard, respectively, and I_{sp} and I_{st} are the measured X-ray line intensities in the specimen and standard, respectively.

The conditions under which a sample may be analyzed, however, can vary appreciably. Different instruments may use different angles of incidence between the electron beam and the sample surface, as well as different take-off angles at which the generated X-rays are sampled. Different operating conditions with the same instrument would include the operating voltage which accelerates the electron beam and the current flowing through the beam.

Since it is necessary to measure the intensity of a particular X-ray line at a particular energy a technique must be used to distinguish between the various lines emitted. The most common approach is to diffract the X-rays using a suitable crystal and then rotate the detector until the desired wavelength is being sampled. This is described in Rucklidge (1976).

A more recent approach, energy dispersive analysis, uses a solid-state, lithium-drifted silicon (Si(Li)) detector. The size of the pulses output by the detector is dependent on the energy of the impinging X-rays, while the frequency of the pulses depends on X-ray intensity (or rate of photon reception). The pulses are therefore catalogued according to their energy and the counts stored. Thus a typical analysis will result in a spectrum of counts in each of 1024 channels, each 10eV wide. While extremely convenient for simultaneously collecting intensities from several X-ray lines, the ability to resolve different energies is not as good as with diffraction methods. Thus characteristic peaks are relatively broad, causing two particular problems. One is that peaks may overlap each other extensively, making it difficult to estimate the intensities of a particular characteristic X-ray line. The other is that, since peaks are about ten times broader than with diffraction methods, ten times as much of the underlying background intensity is incorporated within any one peak. Attempts to perform quantitative energy-dispersive analysis must include handling of these error sources as well as the usual corrections for absorption and other effects, as described below.

5.2 Quantitative Electron Microprobe Analysis

As previously mentioned, the ratio of the intensities of an X-ray line in two samples is approximately the same as the ratios of their concentrations of the element concerned. More accurate analysis, however, requires the introduction of atomic number, absorption and fluorescence corrections. These are discussed in detail in Springer (1976). The atomic number correction includes corrections for the backscattering of reflected incident electrons, which increases with the average atomic number of the sample. Also included is the stopping-power correction which takes account of the decrease in electrons per unit mass as the atomic number increases. Thus unit mass of elements of low atomic number will absorb a larger proportion of the incident electrons than unit mass of elements of higher atomic number. The proportion of effective (X-ray producing) electrons increases with atomic number due to stopping power (S) but decreases due to backscatter (R) effects.

After X-rays have been generated they may be absorbed by the sample before they leave the surface on their way to the detector. The ratio of transmitted to incident intensity is given by $\exp(-\mu_m \rho t)$ where t is the distance travelled, ρ is the element density and μ_m is the mass absorption coefficient for that element for some X-ray energy E_γ. A formula has been derived (Philbert, 1963), making some assumptions about the shape of the volume of sample excited by the electron beam, to express this ratio $f(\chi)$ as a function of Z, A, μ_m, ϕ, E_0 and E_c. Z, A and μ_m are the atomic number, atomic weight and mass absorption coefficient for the element, ϕ, E_0 and E_c are the take-off angle, operating voltage and critical excitation energy for the analysis line.

After generation, some X-rays absorbed by the specimen may have sufficient energy to excite the characteristic radiation of another element present. The X-rays that excite the spurious characteristic radiation may have come from another characteristic line or from the background continuum. The corrections are different in each case and are rather elaborate. Springer (1976) summarizes current atomic number, absorption and fluorescence corrections, and Smith and Gold (1976) describe the equations chosen for correction of energy dispersive analysis data.

5.3 Energy Dispersive Correction Procedures

Because many corrections applied to X-ray intensity measurements assume a knowledge of the sample composition, corrections for samples of unknown composition must be applied in an iterative fashion, such that a previous estimate of the composition is used to apply the corrections to the raw intensities, therefore producing a new and, hopefully, better estimate of the composition. When successive estimates agree closely it is assumed that convergence on the correct composition has been achieved. No difficulties have been encountered with this approach if the initial estimate was reasonable. For energy dispersive analysis in particular, correction procedures may be divided into instrumental calibration corrections, background shaping and scaling, peak overlap correction and composition estimation.

5.4 Instrumental Calibration Corrections

The first requirement for analysis is to know the energy associated with a particular X-ray line intensity. Although an instrument may be designed, for example, to have the lower edge of the first channel set at 0eV and the upper edge at 10eV this will not usually be exact. The approach developed (Smith and Gold 1976) is to collect the spectrum of a calibration standard at the beginning and end of every analytical run. A calibration standard should give strong peaks towards the low and high ends of the spectrum. The common upper limit for analysis being 10 KeV, (10^4 electron volts), willemite was used as the standard, having low energy Zn L_α and Si K_α peaks and high energy Zn $K_{\alpha,\beta}$ peaks.

These calibrations permit the estimation of two sets of instrument parameters for the analytic run - those concerning peak position and those estimating instrument resolution. In both cases the first step is the identification of any peaks present and the precise location of their centres. Peak identification is performed by convolution of the spectrum with a 13-point filter as given in Savitzky and Golay (1964, Table III). The filter shown gives the first derivative of a quadratic function (similar to the top of a Gaussian peak) and hence a change in sign of the derivative from positive to negative will give the peak location to the nearest channel. A closer approximation may be made by making several estimates by interpolation of the full width half maximum (FWHM) of the peak and averaging the mid-points found. The result is usually correct to within 0.1 channels. The FWHM, the usual way of expressing the width of characteristic peaks, is defined as the peak width, measured at a height of half the maximum peak intensity.

The FWHM of a spectrum varies with energy (Smith, 1976). The coefficient E_n gives the FWHM at zero energy, and the Fano factor F is a measure of the increase in FWHM with increasing energy. The FWHM at energy E is $\sqrt{E_n{}^2+21*FE}$. Hence F and E_n for the run may be determined from two peaks in the calibration standard and conversely, once E_n and F are known the FWHM is known for a peak at any energy.

If the two energies of the calibration peaks are found, the peaks are identified and the true energies known, it is straightforward to calculate the instrumental stretch(scaling error) and shift (origin offset) for the run and correct all other spectra. The F and E_n parameters are used to estimate the FWHM of each analyzed element, and hence the window over which integration of intensity is performed. In this fashion further processing of the spectra is independent of the instrument calibration.

After a spectrum has been corrected for these instrumental parameters, escape peaks are stripped from it. Escape peaks are produced within the detector itself because there is a small probability that an incoming photon from the sample may excite the Si dead layer on the surface of the detector and that the resulting characteristic Si K_α radiation may re-emerge through the window of the detector and be lost. The correction for this effect is described in Reed and Ware (1972).

Instrumental and escape peak corrections are applied only once to each spectrum. Other corrections, being dependent on the current estimate of the sample composition, are applied once for each iteration.

5.5 Background Shape

Ware and Reed (1973) note that the detection limit in energy dispersive analysis is governed more by the limitations in background corrections than by the counting statistics. It is therefore of importance that the background correction should be as accurate as possible, but prior to the current work knowledge of the X-ray continuum shape was incomplete. Ware and Reed (1973) suggested that background intensity I at energy E_γ may be calculated from the expression of Kramers (1923):

$$[5.2] \quad I = kZ(E_0 - E_\gamma)/E_\gamma$$

where k is a constant, Z is the average atomic number (proportional to the concentrations of the elements in the sample) and E_0 is the operating voltage used for the analysis. Additional corrections are made to this theoretical spectrum, primarily for absorption in both the sample and detector. This spectrum is then fitted to the raw sample spectrum by scaling at two positions where peaks are unlikely. Correction for backscatter was not attempted, but Rao-Sahib and Wittry (1972) considered this to be necessary and supplied the relevant coefficients. They also modified Kramers' expression for background intensity to

$$[5.3] \quad I = k(E_0 - E_\nu)^x Z^n$$

where x=1.11 and n is a function of E_0, E_ν and Z. However, as noted in Smith _et al._ (1975) I, as the number of photons, should be dimensionless, as is Kramers' expression, whereas Rao-Sahib and Wittry's expression includes units of energy. The precise definition of n was not given, although it was said to vary between 1.2 and 1.37.

Spectra were collected from the following substances: B(metal), C(diamond), MgO(synthetic), Al_2O_3(synthetic), SiO_2(quartz), Si(metal), TiO_2(synthetic), Fe(metal), Fe_2O_3(hematite), Ni_2Si(synthetic) and Cu(metal). Initially these were obtained at E_0 = 15 kV (kilovolts). Escape peaks were stripped from the spectra using the method of Reed and Ware (1972). Some of these samples were also run at 5, 10, 12.5, 20, 25 and 29.5 kV operating voltage.

In order to use Kramers' background expression as suggested by Ware and Reed (1973) it is necessary to correct for absorption effects in the detector itself, especially in the low energy end of the spectrum. This requires accurate knowledge of the thicknesses of the beryllium window, gold contact surface layer and silicon dead layer, with the consequent possibility of error. To avoid this problem Smith (personal communication, 1974) suggested that the ratio, (channel by channel), of two spectra of differing atomic number be used, with adjustments for any differences in probe current or counting time. Thus any deviation of this ratio from unity must be due either to peaks, where it would be ignored, an atomic number-dependent expression for the contimuum intensity, or differences due to incorrect absorption corrections. Various attempts were made to see if errors in calculating the atomic number and the absorption matrix corrections could explain the deviations of observed spectral ratios from unity. Mass absorption coefficients were calculated by the formulae of Frazer (1967), Heinrichs (1966) and Kelly (1966). The parameters h and ρ used in estimating the actual percentage absorption of a particular wavelength in a particular sample were varied widely. Backscatter corrections were made using the expressions of Duncumb and Reed (1968) and Rao-Sahib and Wittry (1972). None of these adjustments were capable of producing the desired unit ratio between pairs of spectra. Subsequent work was performed using Heinrich's (1966) mass absorption coefficients, Philibert's (1963) absorption corrections formulae and Rao-Sahib and Wittry's (1972) backscatter coefficients. Escape peaks were stripped by the method of Reed and Ware (1972).

Since the ratio variation could not be explained by errors in the matrix corrections, it became necessary to examine continuum intensity expressions. This was done by correcting each spectrum for matrix effects, as described above, dividing it by the proposed continuum expression and then dividing one spectrum by the other. If the sample-dependent component of the expression was adequate the ratio should be unity except for peak regions. For Kramers' continuum expression - that is, using each spectrum divided by its atomic number - the ratios are approximately correct at zero continuum energy but deviate extensively with increasing energy and atomic number ratio. By using ratios of spectra obtained at one operating voltage the terms k and $(E_0-E_\gamma)/E_\gamma$ in Kramers' expression, as well as any detector efficiency terms, are eliminated.

Since Kramers' expression was inadequate and the correct expression clearly involved E_0, E_γ and Z an attempt was made to use Rao-Sahib and Wittry's expression involving Z^n. Since they stated that n was dependent on Z, E_0 and E_γ but did not give the relationship, a simple additive model was attempted first, i.e.

[5.4] $n = a + bE_0 + cE_\gamma + dZ.$

Since ratios are calculated for spectra collected at the same operating voltage b cannot be determined from a single ratio plot, hence the expression is reduced to

[5.5] $n = g + cE_\gamma + dZ$

where $g = a + bE_0$. Examination of the ratio at $E_\gamma = 0$

(obtained by extrapolation) showed this to be slightly greater than unity. A range of values of g and d were tried, and the best approximation was found with g = 1.06 and d = 0. The Z-dependent term in n was therefore dropped from further calculations.

If spectra of two substances A and B, obtained at the same operating voltage are compared, the two background shapes can be expressed as Z^n, and n is the same for both spectra at any energy E_ν, then the ratio of background intensities

[5.6] $I_a/I_b = Z_a^n/Z_b^n$.

Hence it can be shown that

[5.7] $n = \log(I_a/I_b)/\log(Z_a/Z_b)$.

Fig. 5 shows plots of n for Cu and C spectra at 5, 10, 15 and 25 kV operating voltage. It can be seen that, allowing for peaks and detector inefficiencies, n is linear. It should be emphasized that the only assumptions made at this stage are that the continuum intensity may be expressed as a function of Z^n, and n itself does not contain a Z term. Kramers' value of n = 1 plots along the base line, and the ranges of n found by Rao-Sahib and Wittry (1972) are shown as dashed lines. While n may fall outside these limits, it does not do so for their combinations of E_0 and E_ν. Since the calculation of n is very sensitive to intensity fluctuations, care must be taken to obtain spectra at the same operating conditions and with as different atomic numbers as possible for the ratio Z_a/Z_b. In addition, regions close to absorption edges should be ignored due to minor errors in the absorption corrections.

The previously-described coefficient g may be obtained from Fig. 5. Its logarithm, plotted against the logarithm of E_0, is shown in Fig. 6. Fig. 7 shows the slope of the lines in Fig. 5, plotted against $\log_{10}(1/E_0)$. Both plots are approximately linear, and in this fashion errors in obtaining these coefficients graphically may be reduced. When the adjusted lines are plotted on Fig. 5 it is clear that they intercept at a common point (N,e in Fig. 5). This suggests a further modification to the expression for n, which may now be rewritten as

[5.8] $n = N + f(E_0)(E_\gamma/e-1)$,

where $f(E_0)$ is the change in n for e keV and is a function of E_0. Fig. 8 shows a plot of $f(E_0)$ against the logarithm of E_0, showing good linearity with

[5.9] $f(E_0) = 0.2532-0.0584 \ln(E_0)$.

The resulting expression for n is

[5.10] $n = 1.159 + (0.2532-0.0584 \ln(E_0))(E_\gamma/2.044 - 1)$

which may be simplified to

[5.11] $n = 1.159 + (0.1239-0.02857 \ln(E_0))(E_\gamma-2.044)$.

In summary, if characteristic peaks are ignored, a spectrum may be corrected so that its shape is independent of its composition, and hence of its average atomic number Z. This is achieved by dividing the observed counts by Z^n, where n is defined above. If the shape is indeed independent of Z then the expression Z^n is a good estimate of the shape

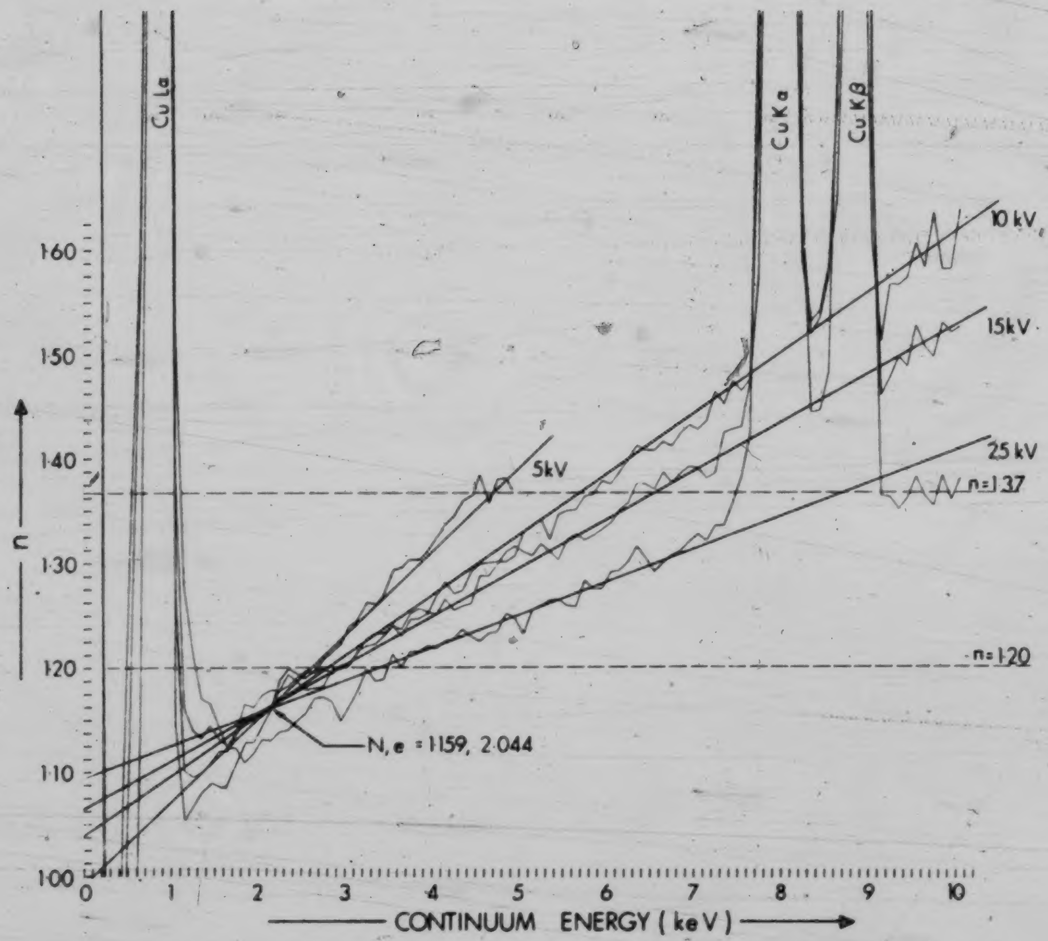


Fig. 5 (From Smith *et al.*, 1975) Plots of n versus continuum energy for various operating voltages, obtained from the ratios of copper and diamond spectra.

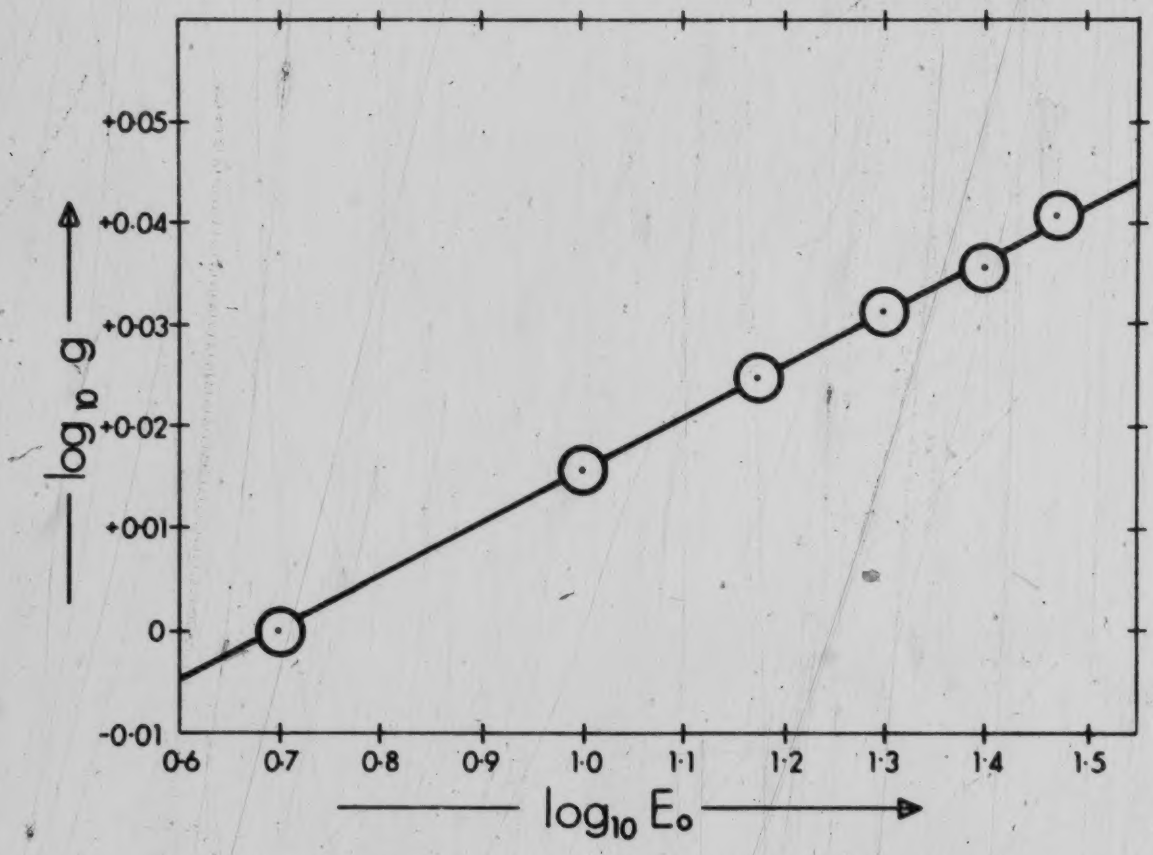


Fig. 6 (From Smith *et al.*, 1975) Logarithmic plot showing the dependence of g on Eo.

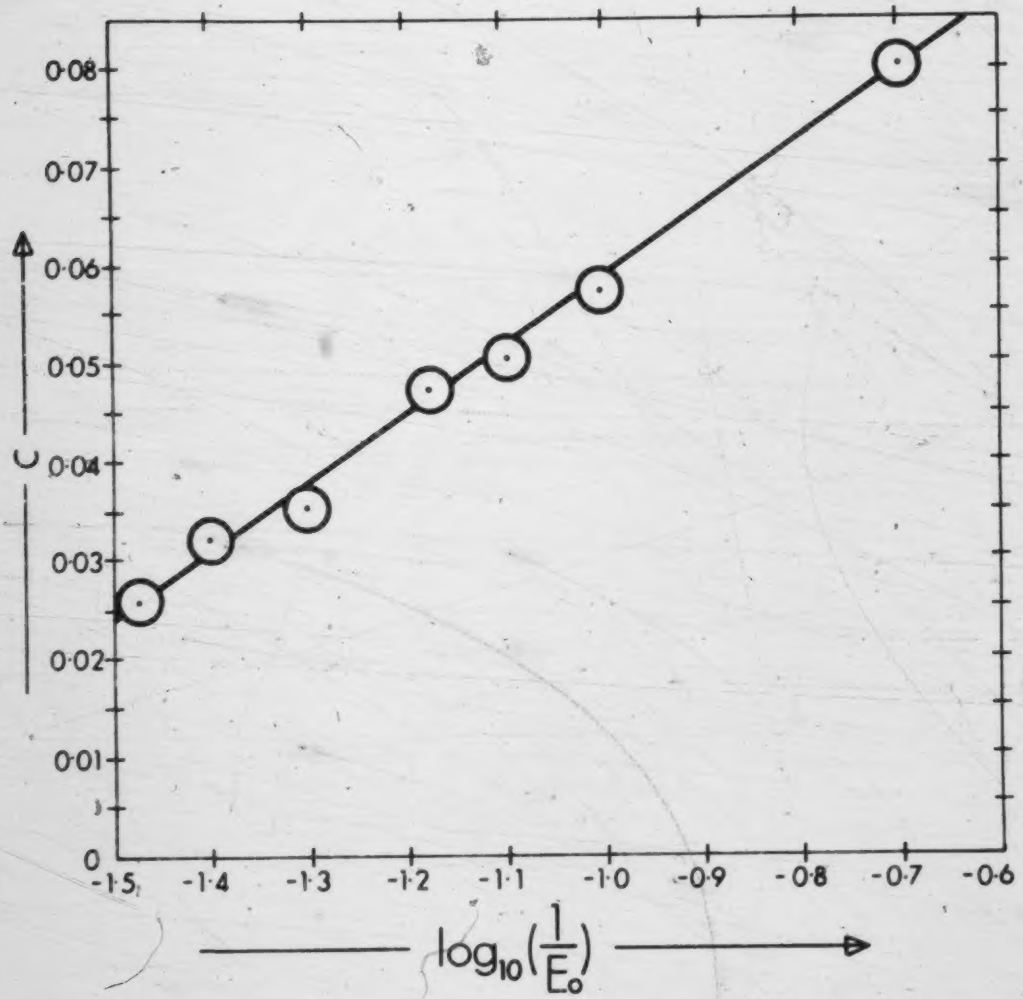


Fig. 7 (From Smith *et al.*, 1975) Plot showing the relationship of c and Eo.

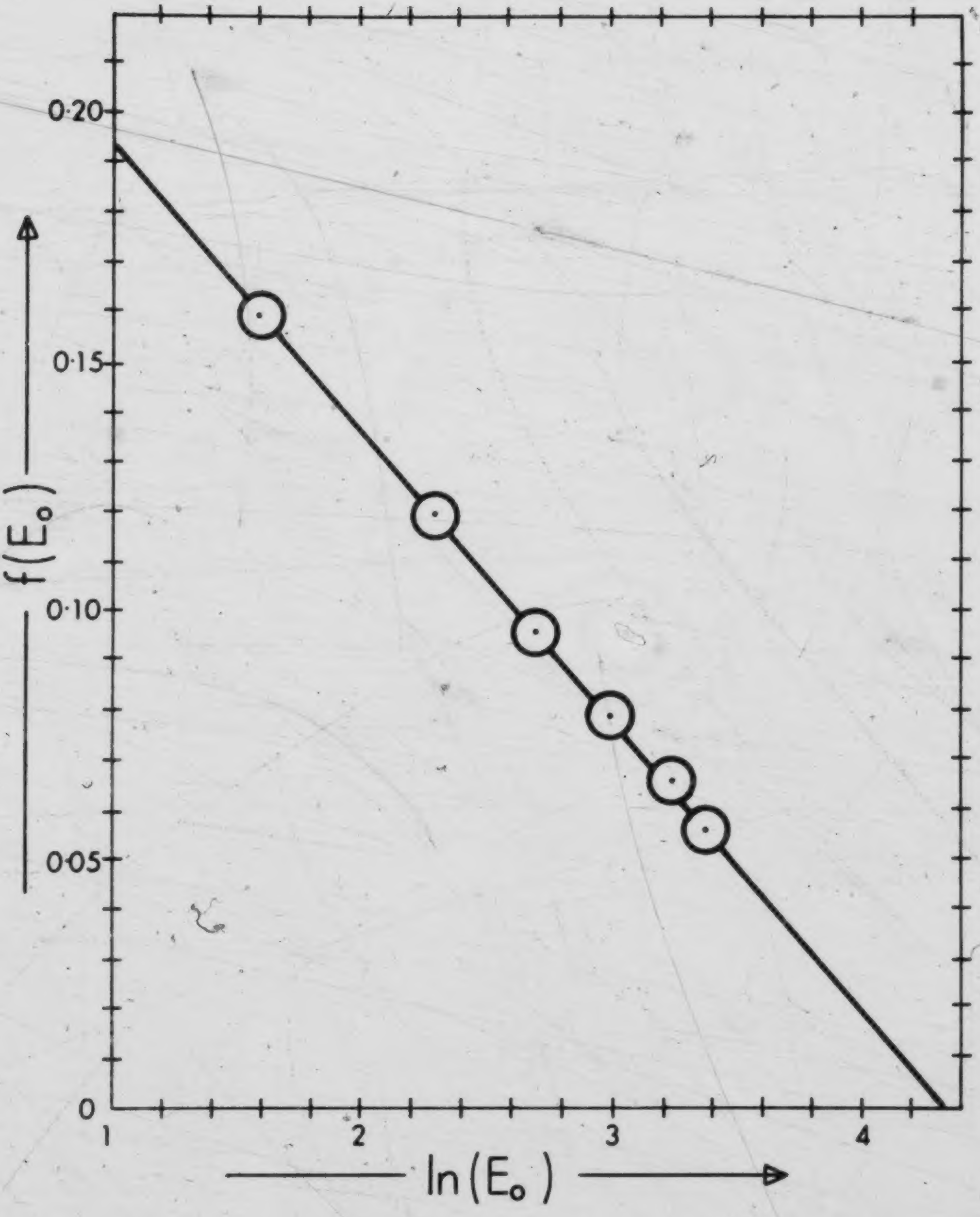


Fig. 8 (From Smith et al., 1975) Plot showing the relationship of f(Eo) to Eo.

of the X-ray continuum.

Fig. 9a shows some of the ratios of spectra corrected using Z^n. Agreement with the expected unit ratio is excellent, as opposed to Fig. 9b which shows similar plots corrected for n = 1 only, as suggested by Kramers. It should be noted that no fundamental significance is necessarily implicit in the form of the expression determined - other expressions may produce even better fits to the data. In addition, the number of significant digits in the coefficients for n may be fewer than given due to the unknown magnitude of errors in absorption and backscatter corrections and instrumental parameters such as probe current and operating voltage. The new expression does, however, provide a superior estimate of the continuum intensity than previous equations. This is indicated by the close approximation to the unit ratio in Fig. 9a, showing that those factors still affecting the continuum shape are not dependent on the compositional differences between samples.

In order to use the continuum expression directly to simulate a background curve for a sample, it would be necessary to know both the E_0-dependent term $-(E_0-E_\nu)^x$ in Rao-Sahib and Wittry (1972) - and the detector efficiency curve due to detector absorption of X-radiation. Hence a less error-prone method was implemented instead. Since the operating voltage of the system is not changed frequently, and the detector efficiency should remain constant, a

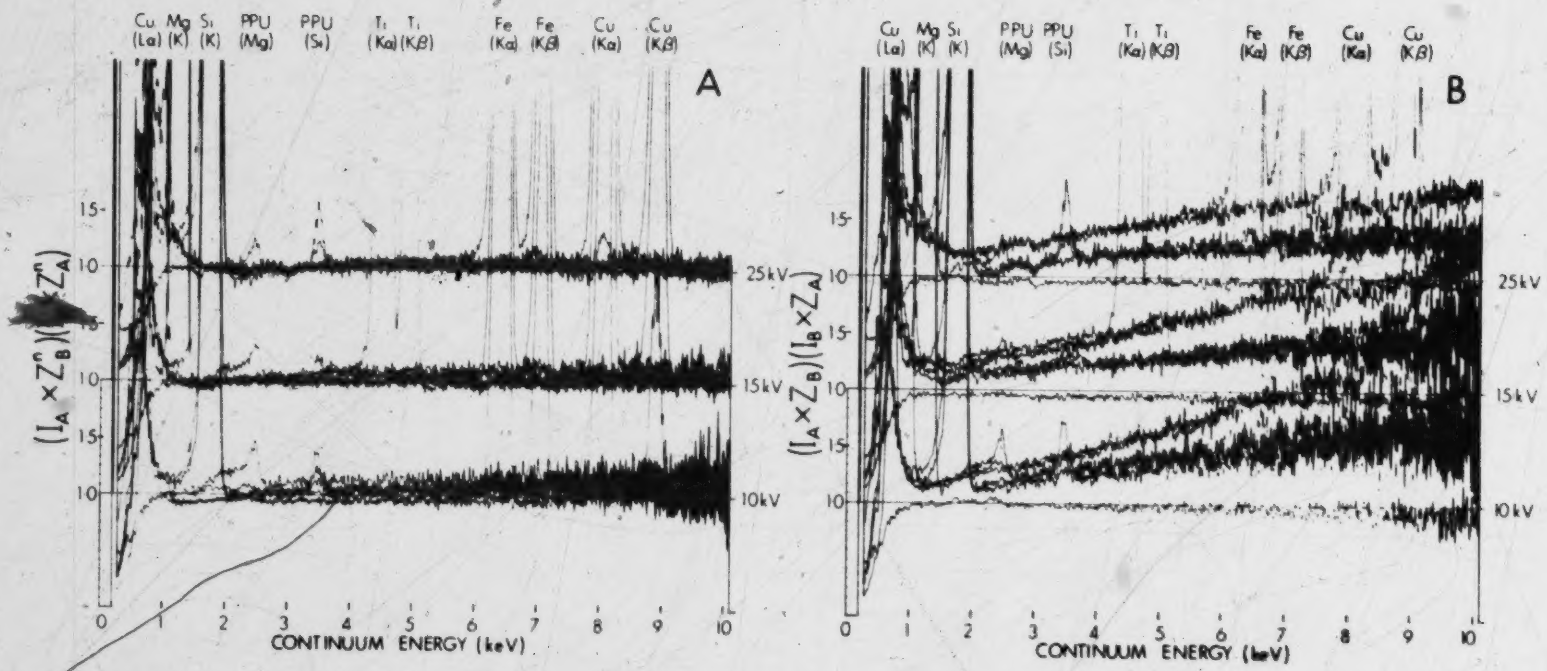


Fig. 9 (From Smith et al., 1975) Plots of the ratios of the Z-corrected spectra of assorted metals and oxides with Z-corrected carbon spectra. Characteristic lines and residual pulse pile-up (PPU) peaks are displayed. (a) shows the approximation of these ratios to unity when the proposed correction is applied. (b) shows the results when Kramers' (n=1) expression is applied.

practical approach is to collect the spectrum of a standard, diamond for example, whose composition is known and which has no characteristic peaks in the region of interest. The spectrum is corrected for matrix effects and divided by Z^n. This "normalized" background should therefore be free of any composition-dependent effects but should reflect any operating voltage and detector-efficiency characteristics. Once prepared, this normalized background is preserved and used for every specimen analyzed under the conditions at which it was taken. Given the estimated or known sample composition, the background is multiplied by Z^n and corrected for matrix effects. Z^n is calculated as $(\sum_i c_i Z_i)^n$ or, more accurately but with greater computational effort, as $\sum_i c_i (Z_i^n)$ where c_i is the concentration of component i. The resulting spectrum should have the shape of a background produced by a sample of that composition.

5.6 Background Fitting

Since different spectra will be acquired with different probe currents and counting times, the shaped background must be scaled to the sample spectrum. Although this could be done using the probe current and counting time, it is more accurate to base the calculations on observed intensities, as this eliminates error due to instrumental drift. Ware and Reed (1973) suggested that scaling be performed using the Ar K_α and Ge K_α energies (2.96 keV and 9.876 keV respectively), which will not normally be interfered with by other peaks. Disadvantages with this approach are that the Ar K_α position may be interfered with by residual pulse pile-up from Al and the intensity of the Ge K_α position is very low, producing poor counting statistics.

In order to scale the whole spectrum to an overall best fit, it is first necessary to eliminate peaks in any averaging. As a first step R_ℓ, the lowest spectrum over background ratio (performed using a 13-channel running average to reduce statistical fluctuations) is obtained. If any of the background is clear of peaks, this ratio will approximate the correct scale factor for the shaped background. An upper limit R_u is then calculated for each channel in turn. A final average ratio is calculated using all channels whose intensity (or number of pulses) I is less than R_u, thus eliminating all significant peaks. The upper limit is calculated as

$$[5.12] \quad R_u = R_\ell(1+3.5/\sqrt{I}).$$

The reciprocal of $\sqrt{I}$ is the standard deviation of the number of pulses I, if I is sufficiently large that the binominal distribution of the counts approaches the normal distribution. Thus the upper limit of the acceptable background ratios is set at 3.5 standard deviations above the lowest ratio found in the spectrum. The number 3.5 was found empirically to provide the best discrimination between peaks and background for the instrumentation used. Energies below 2 keV or above 9 keV were not used, due to the steep slope of the continuum at low energies or the very low count rate at high energies. All spectra were adjusted for stretch and shift, as described earlier in section 5.4, prior to background fitting. Fig. 10 shows the effect of background subtraction on the spectra of ten typical substances. In general the procedure is extremely satisfactory. Slight lows just to the high energy side of some peaks are probably due to inadequacies of absorption corrections for characteristic radiation when applied to the continuum (Smith *et al.*, 1976). Residual counts on the low energy side of peaks just above Si in energy, are low energy tailing and shelving effects due to incomplete charge collection in the silicon detector (Smith 1976).

5.7 Peak Overlap

Since energy resolution is much lower in energy dispersive analysis than in wavelength-dispersive analysis, the overlap of peaks is a frequent occurrence. While attempts have been made to distinguish peaks by assuming Gaussian shape, many overlap conditions are not amenable to this approach, particularly where the non-Gaussian tails of peaks are involved. Consequently a more general approach was applied.

Peaks are separated so that a central part of each may be integrated to produce a measure of the total intensity of that X-ray line. Since F and E_n are estimated for the run, and spectra are therefore automatically corrected for

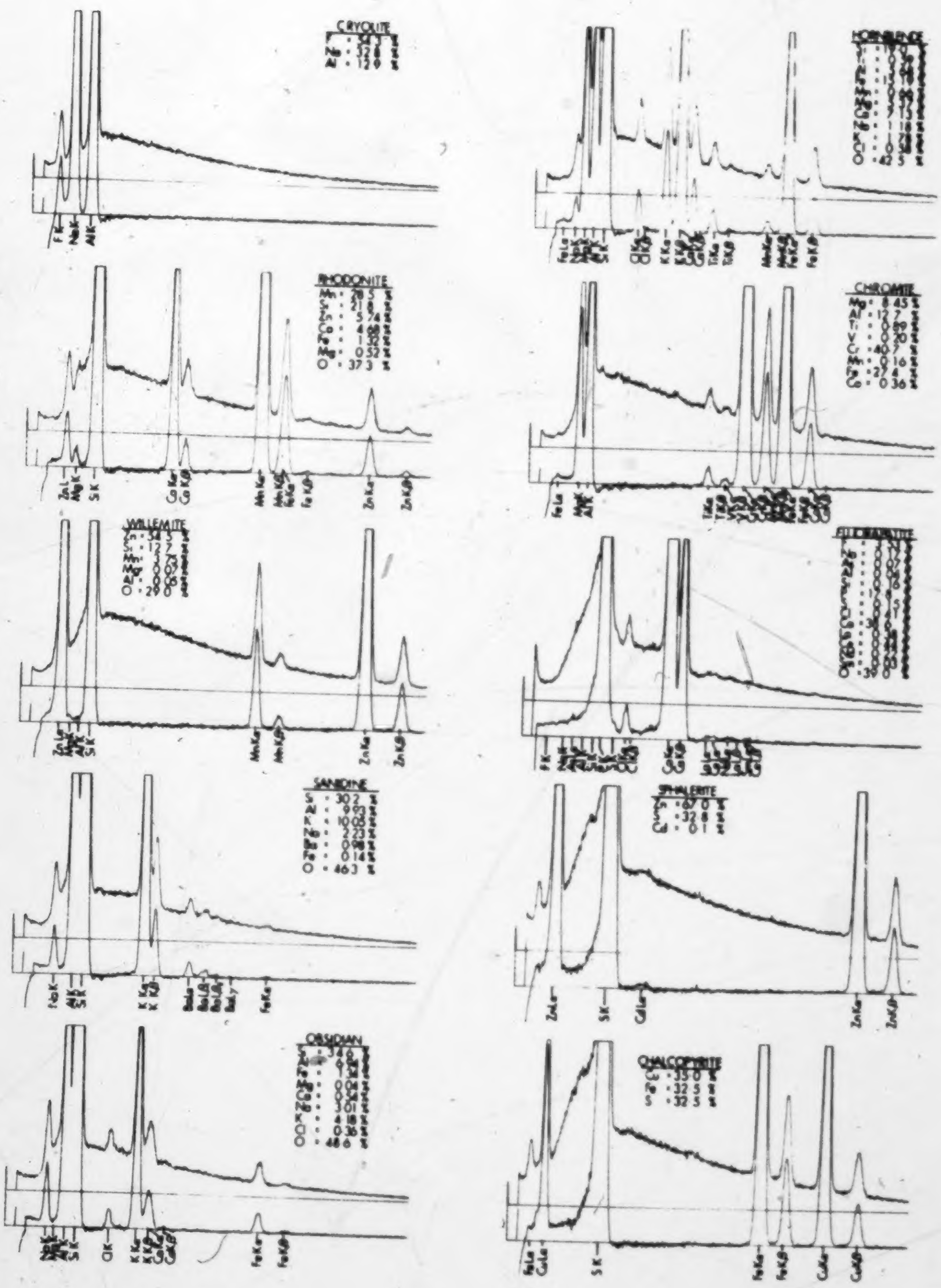


Fig. 10 (From Smith et al., 1975) Spectra of various compounds before (upper) and after (lower) continuum and escape peak removal.

stretch and shift, it is possible to define a run-condition dependent set of integrating regions each covering 1.2 full width half maxima around the peak centre for each analytic line. It is therefore possible to process a set of simple elements or compounds and obtain the above-background intensities that fall within the defined integrating regions. These are expressed as a fraction of the intensity obtained for the analytic line of the element being processed.

Table 5 shows the overlap coefficients for 22 elements commonly used in analysis of silicate minerals. Fig. 11 shows the main features of this table diagrammatically. Overlap coefficients decrease progressively on the low-energy side of parent peaks, but increase as the energy of the parent peak approaches that of the silicon absorption edge. "This pattern indicates that the shelving effects reflected in these overlap coefficients, result largely from partial loss of charge in the silicon deadlayer, as well as from trapping in impurity centres in the detector." (Smith and Gold, 1976, p. 196). In addition, where overlap is produced by element peaks other than the analytic line, differential absorption corrections should be applied. This is the case for the K_β peaks on the high energy side of the analytic K_α line. In addition, atomic number and fluorescence corrections are applicable where L_α peaks overlap some regions of interest and analytic results are obtained using the K_α peak for that element.

----- overlapped element -----

overlapping element	F	Na	Mg	Al	Si	P	S	Cl	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Zr	Ba	overlapping element
F	100	2.10																					F
Na	2.01	100	0.70																				Na
Mg	0.55	1.62	100	0.21																			Mg
Al	0.35	0.46	1.29	100	0.12																		Al
Si	0.29	0.23	0.30	0.90	100	0.19																	Si
P	0.96	1.12	1.55	2.15	4.13	100	0.70														88.14		P
S	0.70	0.67	0.77	0.99	1.40	2.81	100	1.16													3.44		SS
Cl	0.55	0.47	0.43	0.46	0.59	0.90	1.96	100	0.10												1.11		Cl
K	0.49	0.44	0.32	0.22	0.11	0.14	0.24	0.34	100	7.16													K
Ca	0.45	0.35	0.26	0.12	0.08	0.12	0.19	0.33	0.63	100	10.03												Ca
Sc	0.38	0.31	0.20	0.06	0.02	0.03	0.07	0.13	0.23	0.51	100	12.35											Sc
Ti	0.34	0.28	0.17	0.03			0.02	0.05	0.10	0.20	0.40	100	13.70									83.70	Ti
V	0.30	0.24	0.14	0.01				0.01	0.04	0.08	0.17	0.32	100	12.65								0.32	V
Cr	0.25	0.20	0.10	0.01						0.03	0.07	0.15	0.26	100	11.10							0.12	Cr
Mn	0.22	0.16	0.07	0.02							0.02	0.06	0.13	0.21	100	8.20							Mn
Fe	1.29	1.50	0.23	0.03								0.02	0.06	0.13	0.18	100	5.00						Fe
Co	1.26	1.10	0.30	0.05									0.02	0.06	0.12	0.15	100	2.50					Co
Ni	1.24	0.89	0.39	0.05										0.01	0.05	0.09	0.13	100	1.30				Ni
Cu	1.18	24.51	0.61	0.10												0.03	0.06	0.10	100	0.71			Cu
Zn	4.26	282.1	2.07	1.57														0.02	0.07	100			Zn
Zr	0.69	1.14	1.59	2.08	4.69	80.43	5.05	0.13													100		Zr
Ba	1.08	1.92	0.88	0.39	0.25	0.25			0.07	0.33	2.03	95.63	33.38	2.99	2.19						3.11	100	Ba

Overlap coefficients expressed as percentages of measured intensities (1.2 FWHM) in analysis peaks of overlapping elements.
N.B.: where L line overlap coefficients are expressed as percentages of associated K lines, full differential ZAF corrections are applicable. Coefficients in this table are applicable only at the operating voltage used (15 kV) and, strictly, only at the average counting rate of 3000/sec (full spectrum) at which they were obtained. Changes in counting rate producing significant peak broadening will change the coefficients. Also, they are applicable only to a particular detector resolution.

Table 5 (From Smith and Gold, 1976)

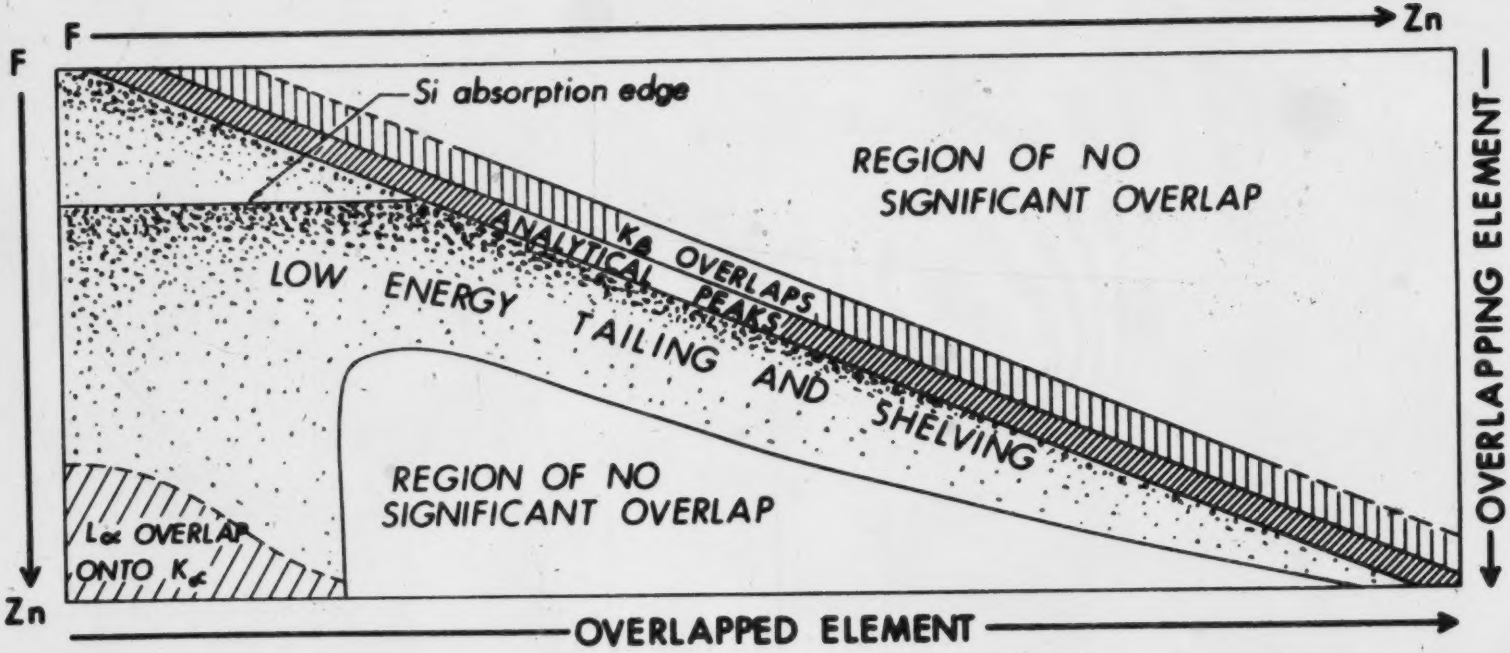

F
Zn
F
Zn
Si absorption edge
REGION OF NO SIGNIFICANT OVERLAP
Kβ OVERLAPS
ANALYTICAL PEAKS
LOW ENERGY TAILING AND SHELVING
REGION OF NO SIGNIFICANT OVERLAP
Lα OVERLAP ONTO Kα
OVERLAPPED ELEMENT
OVERLAPPING ELEMENT

Fig. 11 (From Smith and Gold, 1976) Diagrammatic representation of the overlap coefficients from F to Zn of Table 5.

Since the measured intensities for a sample are the end result of all relevant overlaps, and the overlap coefficients are known, the solution of a set of 22 simultaneous equations for the 22 intensities measured at the locations of the analytic peaks provides the solution for the 22 original intensities prior to overlap. Overlap coefficients are, however, affected by the system resolution, which is affected by the counting rate. Hence all spectra should be obtained at similar counting rates.

5.8 Calculation of Composition

Once intensities are obtained they are corrected for matrix effects as described in section 5.2. Corrected intensities obtained from a sample of unknown composition must then be compared with intensities obtained from standards of known composition in order to estimate the concentration of any particular element. Thus

$$[5.13] \quad C_{sp}/I_{sp} = C_{st}/I_{st}$$

where sp and st refer to specimen and standard, respectively, and C and I are concentration and corrected intensity, respectively. Standards must therefore be processed in each run for each element analyzed, prior to the analysis of an unknown. Fig. 12 shows a typical printout for a standard, using the EDATA program (Gold and Smith, 1976). While this is undoubtedly the most accurate method, a considerable saving in analysis time can be made if approximate standard intensities can be preserved from

```
****************************************
NEW SPECTRUM, TIME=   400 SEC.

CCNM0279 SANIDINE SMM4-21
PERCENTAGES:
  30.23SI 14   0.0 TI 22   9.93AL 13   0.14FE 26    0.0 CA 20
  2.23NA 11  10.05K  19   0.98BA 56  46.28O   8
AV. Z=       11.9847
MIN E =   208
SBR=  0.003022

  PEAK     INT.     P/B R.  FWHM.
 1484.01  425362     8.56  126.05 AL  KA
 1736.19 1538250    26.97  126.10 SI  KA
 3313.64  416700    10.76  141.01 K   KA
 4459.83   11866     0.36  145.30 BA  LA   LOW P/B
CALIBRATION STANDARD: SHIFT=   1.933 STRETCH=-.00044 USED.
FANO=  0.114934 ENOISE=110.363052 USED
MIN E =   208
SBR=  0.998232
OVERLAP CONVERGENCE: ITERATIONS=  25

  Z       A       F      ZAF      CTS      C/S  ZAF*C/S    STD.     WT.FR. EL.
 1.0794 1.0576 0.9996 1.1410 425832. 1064.58 1214.71 0.0000827 0.10050 K
 1.5529 0.9877 0.9998 1.5335  11156.   27.89   42.77 0.0002291 0.00980 BA
```

Fig. 12 Sample EDATA printout for a standard.

previous runs for use in estimating the concentrations of minor or unexpected elements. For this purpose standard intensities are preserved in a standardized form suitable for use in any run. Intensities are recorded as counts per second per nanoamp of probe current per percent of that element present in the standard. While not as accurate as run-time standards they have appreciable value. Fig. 13 shows the EDATA printout for a typical sample analysis. In the last line under "OLD STDS.", can be seen the standard numbers used for each element. In this list a zero indicates that default standard values were used.

5.9 Sequence and Implementation of Correction Procedures

The normal procedure for analysis of an unknown therefore contains the following steps.

1/

The sample spectrum is corrected for stretch and shift and escape peaks are stripped from it.

2/

The spectrum is scaled to standard probe current.

3/

An initial estimate of composition is made.

4/

The normalized background is shaped using the current composition estimate, involving the application of matrix and Z^n corrections.

5/

```
****************************************
NEW SPECTRUM, TIME=   400 SEC.

CODE0152 ILMENITE ODEGAARDEN SMM2-5
AV. Z=      20.4546
MIN E =    753
SBR= 40.001689

  PEAK      INT.     P/B R.  FWHM.
 4502.44  964862   21.96  148.77 TI  KA
 4922.92  141587    3.44  162.64 TI  KB   LOW P/B
 6388.19  675969   23.01  166.52 FE  KA
 7041.18   92513    3.56  179.26 FE  KB   LOW P/B
CALIBRATION STANDARD: SHIFT=   1.604 STRETCH=0.00144 USED.
FANO=  0.128998 ENOISE=104.481720 USED
AV. Z=        19.1592
MIN E =    754
SBR=  0.002788
OVERLAP CONVERGENCE: ITERATIONS=  19
END OF LOOP# 4

  Z       A       F      ZAF       CTS      C/S   ZAF*C/S     STD.     WT.FR. EL.
 0.8925 1.6296 1.0029 1.4586  10414.    26.04    37.98 0.0001437 0.00546 MG
 0.9779 1.0076 0.9666 0.9525 985637. 2464.09 2347.04 0.0001214 0.28503 TI
 1.0922 1.0005 0.9469 1.0348   6511.    16.28    16.84 0.0001285 0.00216 V
 1.1032 1.0216 0.9998 1.1268   6066.    15.16    17.09 0.0001756 0.00300 MN
 1.0089 1.0172 1.0000 1.0263 689772. 1724.43 1769.72 0.0002211 0.39122 FE
 1.1164 1.0103 1.0000 1.1279   1387.     3.47     3.91 0.0002650 0.00104 CO
   4 ITERATIONS, FINAL RESULTS:
  H        HE       LI        BE       B        C        N        O        F        NA
  0.0      0.0      0.0       0.0      0.0      0.0      0.0      31.209   0.0      0.0
  MG       AL       SI        P        S        CL       K        CA       SC       TI
  0.546    0.0      0.0       0.0      0.0      0.0      0.0      0.0      0.0      28.503
  V        CR       MN        FE       CO       NI       CU       ZN       ZR       BA
  0.216    0.0      0.300     39.122   0.104    0.0      0.0      0.0      0.0      0.0

  PEAK      INT.       FWHM.
 1243.91    13994     128.68 MG  KA
 2767.18     1077      53.34 PK.UNKN.
 4510.63   960702     149.09 TI  KA
 4932.88   139716     161.76 TI  KB
 6399.19   674896     166.81 FE  KA
 7053.40    92391     179.92 FE  KB
OLD  FFFNNNMMMAAASSSPPPSSSCCCKKKCCCSSSTTTVVVCCCMMMFFFCCCNNNCCCZZZZZZBBB
STDS.    AAAGGGLLLIII       LLL    AAACCCIII    RRRNNNEEEOOOIIIUUUNNNRRAAA
       0  0106  0106  0  0  0  0  0  0271  0  0  0137  0  0  0  0  0  0
```

Fig. 13 Sample EDATA printout for a sample of unknown composition.

The background spectrum is scaled to fit the sample spectrum, and subtracted from it.

6/

Integrated intensities are obtained over standardized regions of interest for each element, using the background-stripped sample spectrum.

7/

The integrated intensities are corrected for peak overlap.

8/

Resulting intensities are corrected for atomic number, absorption and fluorescence effects.

9/

New compositional estimates are made by comparison with standard intensities.

10/

If the current and previous composition estimates are sufficiently close (within 0.05% for all elements) calculation ceases. Otherwise the procedure is repeated from step 4.

Fig. 14 shows a schematic flow chart of the EDATA package. After subroutine INIT initializes parameters for the run a spectrum is read and standardized by subroutine READIN, and, if this spectrum is of a sample of unknown composition, the initial composition is estimated from the raw peak intensities by calling SCAN with a parameter of zero. After this , subroutine SHAPE is called to shape the

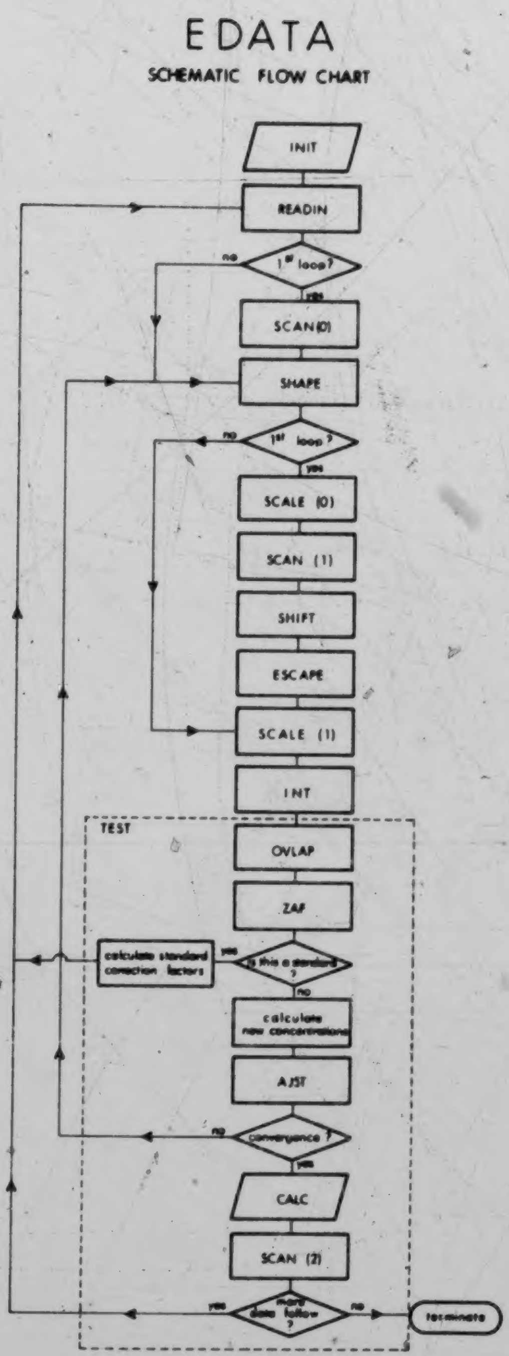

EDATA
SCHEMATIC FLOW CHART
INIT
READIN
no
1st loop?
yes
SCAN(0)
SHAPE
no
1st loop?
yes
SCALE (0)
SCAN (1)
SHIFT
ESCAPE
SCALE (1)
INT
TEST
OVLAP
ZAF
calculate standard correction factors
yes
is this a standard ?
no
calculate new concentrations
AJST
no
convergence ?
yes
CALC
SCAN (2)
yes
more data follow ?
no
terminate

Fig. 14 Schematic flowchart for the EDATA program.

normalized background to the sample spectrum, SCALE with a parameter of zero is used to fit the shaped background to the raw spectrum, and SCAN with a parameter of one is used to search for and display all major peaks and their size with respect to the background (see Figs. 12 and 13). Following this, SHIFT is called to adjust the raw spectrum for any instrumental stretch and shift as estimated from the calibration standards, ESCAPE is called to strip off the escape peaks, and SCALE with a parameter of one does a final scaling adjustment to fit the background to the shifted sample spectrum. Subroutine INT then integrates both the shifted spectrum and the scaled background over the region of interest for each of the 22 elements, as estimated from the FWHM of the calibration standards. The spectrum-minus-background figure for each element forms the intensity value used to generate subsequent compositional estimates.

Subroutine TEST handles all subsequent processing of intensities. OVLAP is called to estimate the original intensities in the absence of any peak-to-peak overlapping. ZAF corrects these intensities for atomic number, absorption and fluorescence effects. Processing of standards terminates at this point with the derivation of standard correction factors in the form of weight fraction of an element per ZAF-corrected count / second intensity, to be used for compositional estimates on subsequent samples. Thus, in Fig. 12, the values in the "STD." column are obtained by dividing the known standard composition values in the "WT.FR." column by the intensities in the "ZAF*C/S" column. In the case of a sample being analyzed (Fig. 13) the new concentrations ("WT.FR." column) are calculated by multiplying the intensities in the "ZAF*C/S" column by the values under "STD.". Subsequently a user-defined AJST routine is called to modify the concentration estimates, e.g. by estimating the oxygen concentration as the difference between the compositional total and 100%. This compositional estimate is then used in loop 2. On the second or subsequent iteration only SHAPE (to reshape the background on the basis of the new composition estimate), SCALE with a parameter of one (to scale this background to the initial shift, stretch and escape peak corrected spectrum) and INT (to calculate peak intensities) are called prior to re-entering the TEST subroutine. After new concentration estimates are obtained they are compared with the previous values, and a further iteration is performed if any element deviates from the previous value by 0.05% or more. If, however, convergence has been achieved, the user-defined subroutine CALC is entered (perhaps to recalculate elemental concentrations as oxides), SCAN with a parameter of two searches for peaks on the background-subtracted spectrum (Fig. 13, bottom) and the program proceeds to read and process any subsequent spectra.

Further details of the computer implementation of this approach as the EDATA package are contained in Gold and Smith (1976). Typical analyses obtained using this system are shown in Table 6, from Smith and Gold (1976). For major

	FORSTERITE		SANIDINE		ANHYDRITE		SPHALERITE		TROILITE		OBSIDIAN		GLASS WRAB-4		GLASS BCR-1		ILMENITE			
O	45.58	45.48	45.92	46.28	46.06	47.01	-	-	-	-	49.13	48.63	44.52	45.01	44.69	44.73	31.40	31.72	30.57	C
Na	-	-	2.10	2.23	-	-	-	-	-	-	3.04	3.01	1.89	1.70	2.58	2.50	-	-	-	Na
Mg	34.29	34.56	-	-	-	-	-	-	-	-	-	0.04	6.15	5.68	1.97	2.10	0.43	0.58	0.41	Mg
Al	-	-	10.22	9.93	-	-	-	-	-	-	6.88	6.94	9.52	9.56	7.12	7.39	-	-	-	Al
Si	19.97	19.96	30.22	30.23	-	-	-	-	-	-	34.58	34.56	22.48	22.57	25.71	25.72	-	-	-	Si
P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.14	0.20	-	-	-	P
S	-	-	-	-	23.62	23.55	33.32	33.10	36.48	36.50	-	-	-	-	-	0.03	-	-	-	S
Cl	-	-	-	-	-	-	-	-	-	-	0.30	0.36	-	-	-	-	-	-	-	Cl
K	-	-	10.15	10.05	-	-	0.06	-	-	-	4.20	4.18	0.05	0.13	1.39	1.42	-	-	-	K
Ca	-	-	0.23	0.01	30.27	29.44	-	-	-	-	0.61	0.54	8.03	8.23	4.95	5.04	-	-	-	Ca
Sc	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Sc
Ti	-	-	-	-	-	-	-	-	-	-	-	0.04	0.44	0.41	1.42	1.36	28.78	28.59	29.78	Ti
V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.04	0.37	0.17	0.37	V
Cr	-	-	-	-	-	-	-	-	0.06	0.08	-	-	-	-	-	-	-	-	-	Cr
Mn	-	-	-	-	-	-	-	-	-	-	-	0.05	0.12	-	0.13	0.14	0.32	0.23	0.30	Mn
Fe	-	-	0.11	0.14	-	-	2.68	2.90	63.05	63.16	1.18	1.34	6.77	6.69	9.61	9.60	38.67	38.69	38.58	Fe
Co	-	-	-	-	-	-	-	-	0.24	0.05	-	-	0.04	-	0.05	-	-	-	-	Co
Ni	0.05	-	-	-	-	-	-	-	-	0.10	-	-	-	-	-	-	-	-	-	Ni
Cu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Cu
Zn	0.05	-	-	-	0.05	-	64.78	64.10	0.45	-	0.07	-	-	-	0.08	0.01	0.03	0.01	-	Zn
Zr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Zr
Ba	0.06	-	1.01	0.98	-	-	-	-	-	-	-	-	-	-	0.18	0.08	-	-	-	Ba

Typical analyses obtained using techniques outlined. The first column of each pair shows results of energy dispersive analysis; values not underlined were obtained by the default standard option; all oxygen values are calculated by difference from 100%. The second columns show the best available information on composition. The third column of the ilmenite analysis shows values obtained using the default option for all elements, including majors.

Table 6 (From Smith and Gold, 1976)

elements the accuracy is possibly better than that obtainable by wavelength dispersive analysis, since all elements were analyzed at exactly the same points on the sample, and their intensities were collected simultaneously. For minor elements, present in concentrations greater than about 0.25%, accuracies are similar, but below this accuracies become appreciably worse than with wavelength dispersive analysis, although with care concentrations of 500 ppm may be detected. Currently the detection limit is considered to be 300ppm. In Table 7 the best available analyses found in the literature (column 2) for an obsidian sample are compared with an analysis using energy dispersive analysis and EDATA (column 1). Elements underlined were calculated using standards processed during the run, while Cl and Mn were calculated using default standards.

OBSIDIAN

	(1)	(2)
O	48.61	48.63
Na	3.19	3.01
Mg	-	0.04
Al	6.91	6.94
Si	34.94	34.56
P	-	-
S	-	-
Cl	0.32	0.36
K	4.36	4.18
Ca	0.52	0.54
Sc	-	-
Ti	-	0.04
V	-	-
Cr	-	-
Mn	0.05	0.05
Fe	1.15	1.34
Co	-	-
Ni	-	-
Cu	-	-
Zn	-	-
Zr	-	-
Ba	-	-

Table 7 Comparison of analyses performed by the EDATA program (1), with the best available values (2). Run time standards are underlined. Oxygen is obtained by difference.

6.0 AUTOMATED CONTOUR MAPPING TECHNIQUES

6.1 Conventional Contour Mapping Techniques

Contour mapping is an attractive approach for the display of the chemical variation in the analyzed till samples, or the elevation of the contacts between stratigraphic units. Available computer techniques were considered unsatisfactory for a variety of reasons. Computer programs using traditional surface estimation methods to produce contour maps follow a fairly standard procedure. A suitable rectangular grid is superimposed over the map area, and an elevation estimate made at each grid node. Estimation techniques vary widely, but usually consist of selecting n neighbouring data points, evaluating an inverse distance weighting function for each (giving less weight to more distant points), and then calculating a weighted average for the values obtained from these data points (e.g. Sampson, 1975). Once the grid node values are obtained, straight line (or, occasionally, curved) contour segments are obtained for a desired contour value by interpolation from the values at the corners of each rectangle. Reviews of the multitude of contouring methods are given by Rhind (1975), Walters (1969) and Crain (1970). Some of the better known publications on the subject are Shepard (1968), Cottafava and LeMoli (1969) and Dayhoff (1963).

Several problems remain with most gridding methods. One is the use of an assumed arbitrary distribution function such as $1/d^2$, where d is the distance of the data point from the grid point whose value is to be determined. An excellent discussion of distance weighting functions is given in McLain (1974). Another difficulty occurs in the definition and collection of the "neighbouring" data points. This does not necessarily mean "closest" since it is desirable that the points surround the location under examination. Collection and testing of the data points is frequently expensive since there is no direct method of locating the nearest points to any arbitrary map location, and so some form of search of the whole data set is necessary. If the weighting of a data point has not reached zero when it is rejected from the set of neighbours being used to estimate elevations in a region of the map, then discontinuities in the surface may occur with weighted average techniques. Further problems are (1) the grid size defines the final resolution irrespective of data point distribution since further processing consists of interpolation between grid nodes, not data points, (2) interpolation of contour segments in a rectangle is not always unique or trivial due to the difficulty in distinguishing a north-east trending ridge from a north-west trending valley (or vice-versa), (3) fairly extensive programming may be required in order to string all the contour segments together for plotting and (4) elevations of the defined surface may not pass precisely through the data points. For topographic maps this last property is undesirable, but for data with an appreciable error component some smoothing may be desirable. Gold (1977) discusses some aspects of the selection of a suitable contouring method.

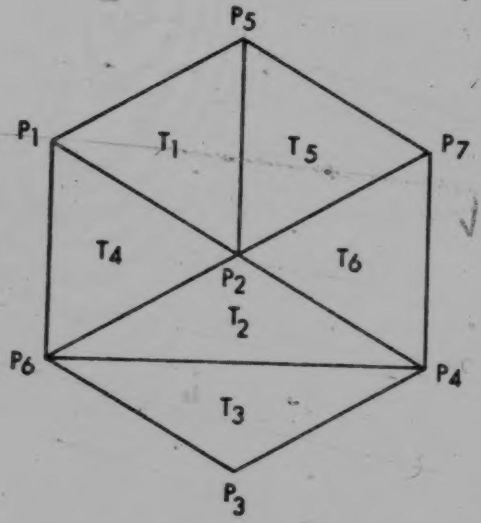
6.2 Triangular Element Data Structures and Coordinates

Contour mapping using triangular element data structures possesses several advantages in dealing with the above problems. The general approach is to break the map region into triangles with data points at the vertices, obtain the slopes at each vertex and bend triangular plates to conform to these. Each of these irregular triangles is represented by an element in the data structure, with pointers to the three adjacent triangles and the three associated data points (Fig. 15). A data structure of this type that was defined manually rather than automatically is described by Heap (1972).

In order to understand the benefits of the suggested data structure it is important to understand its construction and properties. The fundamental concept is the availability of a local homogeneous coordinate system r_i ($i = 1$ to 3) associated with each triangle (Fig. 16a). Thus an arbitrary point p at location (x_p, y_p) may be located with reference to a particular triangle with vertices at the points i = 1, 2, 3 (numbered anticlockwise) by

[6.1] $r_i = d_i / D$ where

Map elements


P5
P1
P7
T1
T5
T4
T6
P2
T2
P6
P4
T3
P3

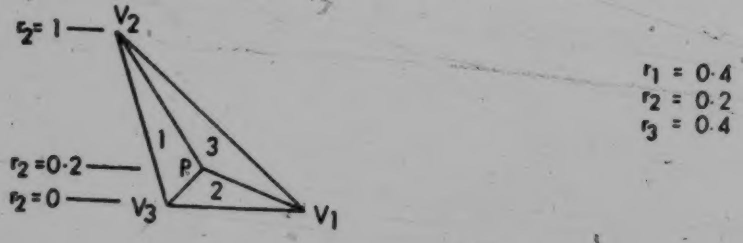
Data elements

Triangle #	Adjacent Triangles	Associated Data Points
1	5,–,4	1,2,5
2	3,6,4	2,6,4
3	2,–,–	3,4,6
4	2,1,–	1,6,2
5	1,6,–	7,5,2
6	2,–,5	7,2,4

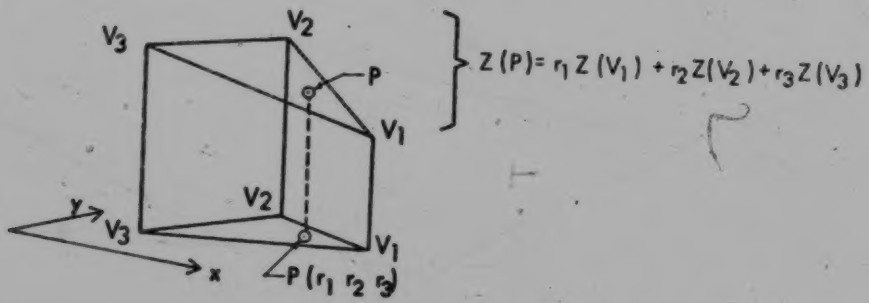
Point #	X	Y	Z (elevation)
1	X_1	Y_1	Z_1
2	X_2	Y_2	Z_2
3	X_3	Y_3	Z_3
4	X_4	Y_4	Z_4
5	X_5	Y_5	Z_5
6	X_6	Y_6	Z_6
7	X_7	Y_7	Z_7

Fig.15 (From Gold *et al.*, 1977) Triangular element data structures.

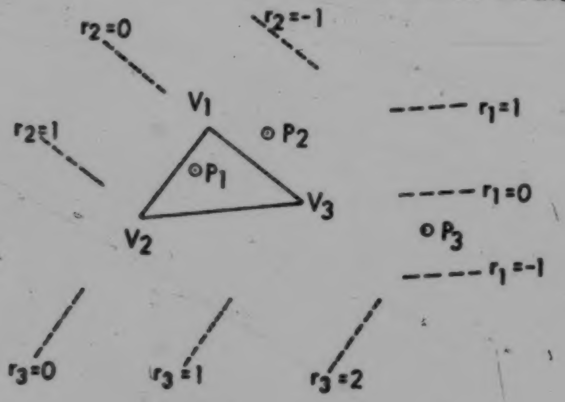
a) Local coordinates


$r_2 = 1$
V_2
$r_2 = 0{\cdot}2$
$r_2 = 0$
V_3
1
3
P
2
V_1
$r_1 = 0{\cdot}4$
$r_2 = 0{\cdot}2$
$r_3 = 0{\cdot}4$

b) Planar interpolation of elevations


V_3
V_2
P
V_1
$Z(P) = r_1 Z(V_1) + r_2 Z(V_2) + r_3 Z(V_3)$
V_2
y
V_3
V_1
x
$P(r_1\ r_2\ r_3)$

c) Local coordinates and search strategies


$r_2 = 0$
$r_2 = -1$
V_1
$r_1 = 1$
$r_2 = 1$
P_2
P_1
V_3
$r_1 = 0$
V_2
P_3
$r_1 = -1$
$r_3 = 0$
$r_3 = 1$
$r_3 = 2$

Point	r_1	r_2	r_3
P_1	0·4	0·4	0·2
P_2	0·8	-0·3	0·5
P_3	-0·4	-0·6	2·0

Fig.16 (From Gold *et al.*, 1977) Derivation and use of a local homogeneous coordinate system for a triangle.

[6.2] $$d_1 = \begin{vmatrix} x_p & y_p & 1 \\ x_2 & y_2 & 1 \\ x_3 & y_3 & 1 \end{vmatrix}; \quad d_2 = \begin{vmatrix} x_1 & y_1 & 1 \\ x_p & y_p & 1 \\ x_3 & y_3 & 1 \end{vmatrix}; \quad d_3 = \begin{vmatrix} x_1 & y_1 & 1 \\ x_2 & y_2 & 1 \\ x_p & y_p & 1 \end{vmatrix}; \quad D = \begin{vmatrix} x_1 & y_1 & 1 \\ x_2 & y_2 & 1 \\ x_3 & y_3 & 1 \end{vmatrix}$$

The value d_i may be thought of as twice the area of sub-triangle i, and D as twice the area of the reference triangle. This is the solution of the system of linear equations:

[6.3] $$\begin{aligned} x_p &= r_1 x_1 + r_2 x_2 + r_3 x_3 \\ y_p &= r_1 y_1 + r_2 y_2 + r_3 y_3 \\ 1 &= r_1 + r_2 + r_3 \end{aligned}$$

In addition, if planar interpolation of elevations is required,

[6.4] $$z_p = r_1 z_1 + r_2 z_2 + r_3 z_3$$

as illustrated in Fig. 16b.

This coordinate system was first devised by Feuerbach (1827) for tetrahedra and variations on it were extensively used by geometers of that century. Each of these three coordinates (r_i) has the value 0 when p falls on the base line i, and 1 when p falls on a line parallel to base line i, but passing through the opposite vertex i. The three coordinates sum to unity, hence any two define the third. All three coordinates are positive if p falls within the triangle, and if p falls outside, the signs of the coordinates indicate the direction to go looking for a circumscribing triangle.

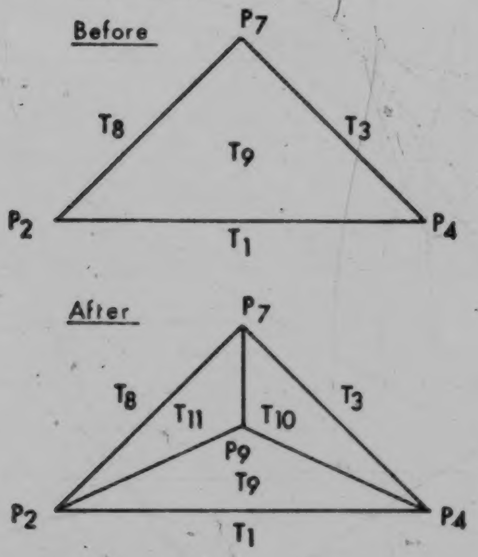
6.3 Data Structure Generation and Optimization

It is clear from Fig. 16c that, if a data structure relating adjacent triangles exists, a search algorithm is easily devised to start at any arbitrary triangle and search through a set of adjacent triangles until the one enclosing the unknown point is located. This in itself suggests a method for generating such a data structure. A "universal" triangle, large enough to enclose the map area, is first generated. The data points are inserted one at a time and the enclosing triangle for each is located. This triangle is then divided into three new triangles with the new point at a vertex common to all three, and all pointers are then updated (Fig. 17a).

The resulting mesh of triangles is continuous over the map area but the triangles produced may have undesirable shapes. An optimization routine is then used to test each triangle against each of its neighbours. The quadrilateral thus formed, if convex, may be divided in two ways, and it is the purpose of the optimization criterion to choose one of them. If the current division is the poorer of the two then the quadrilateral is divided in the alternative manner and the data structure pointers updated as in Fig. 17b. In this manner every triangle pair in turn is examined to see if it is acceptable and, if not, the alternative partition is taken. This procedure is repeated until an entire pass through the data structure produces no changes. By the judicious setting of flags the optimization of even a few

a) Inserting new data points

Map elements

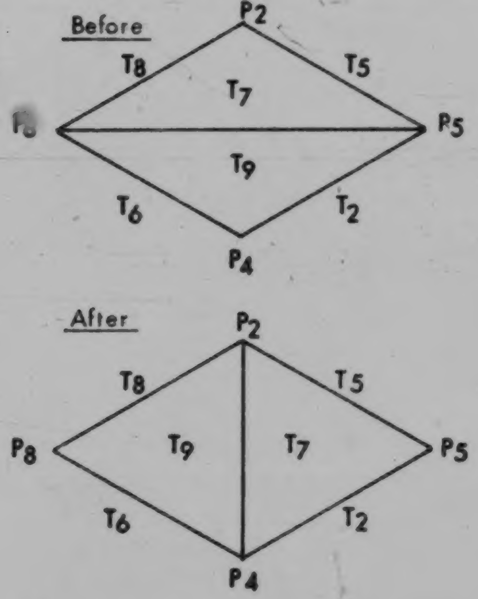


Before
P7
T8
T9
T3
P2
P4
T1
After
P7
T8
T11
T10
T3
P9
T9
P2
P4
T1

Data elements

	Triangle #	Adjacent Triangles	Associated Data Points
Before	9	1, 3, 8	7, 2, 4
After	9	1, 10, 11	9, 2, 4
	10	9, 3, 11	7, 9, 4
	11	9, 10, 8	7, 2, 11

b) Quadrilateral optimization



Before
P2
T8
T7
T5
P5
T9
T6
T2
P4
After
P2
T8
T5
P8
T9
T7
P5
T6
T2
P4

Before	7	9, 5, 8	2, 8, 5
	9	7, 6, 2	4, 5, 8
After	7	2, 5, 9	2, 4, 5
	9	8, 6, 7	4, 2, 8

Fig.17 (From Gold *et al.*, 1977) Triangular data structure generation and optimization.

thousand triangles remains an economic proposition, the insertion and optimization of 1129 data points requiring 0.22 and 1.92 seconds respectively on an Amdahl 470/V6 computer for a test data set. These flags are set to define triangle pairs that have been tested and found satisfactory, and hence need not be tested again until one of the two triangles has been redefined. Fig. 18 (solid line) illustrates the rate of convergence of the iterative optimization. The natural logarithm of the number of switches made decreases by close to one third on each iteration, and hence the number of iterations approximates 3 ln(T) where T is the number of triangles. This is a worst-case condition since the dashed line shows the convergence rate for a second batch of data points inserted after the first set had been optimized. This approach seems to have considerable economic advantages over the methods of Frenkel and Gill (1975) and McLain (1976) in which the mesh is built up agglomeratively from some nucleus by testing all neighbouring points to find the one most suitable to be added at a specific mesh location. Lawson (1977) generates a mesh by first finding the convex hull of the set of data points and agglomeratively building the mesh within this. Optimal triangulation (as defined in Section 6.4) is achieved by testing triangle pairs, as is done in this work. The use of a fast triangulation algorithm, as suggested here, may permit the contouring of moderate to large data sets several times faster than by gridding methods.

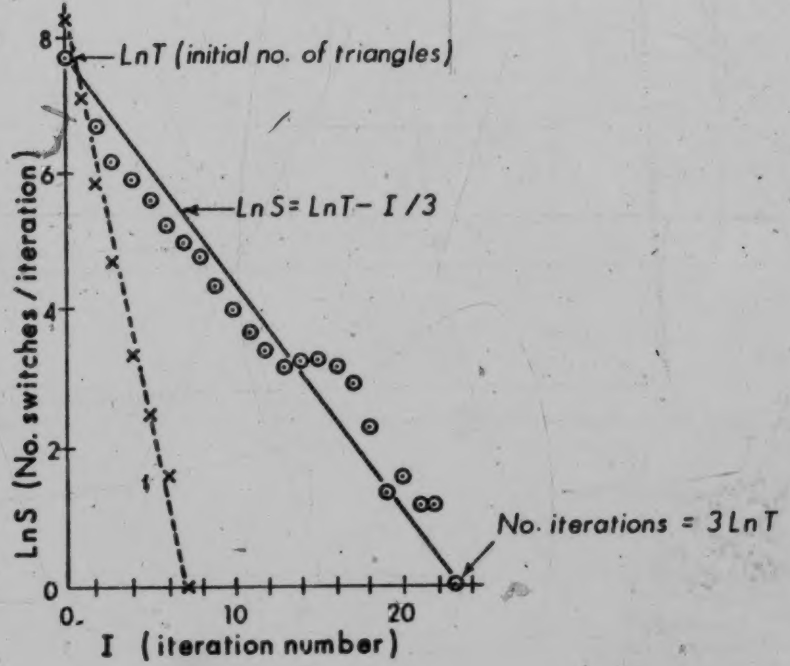
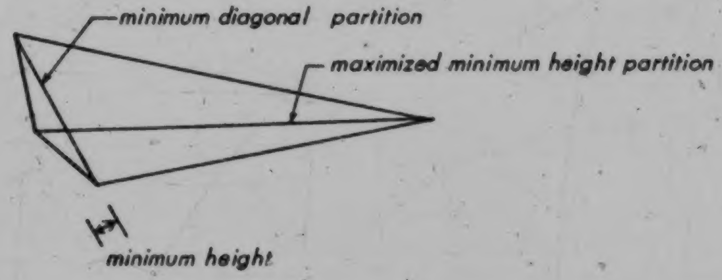


Fig. 18 (From Gold et al., 1977) Rate of convergence of optimization of a triangular mesh.

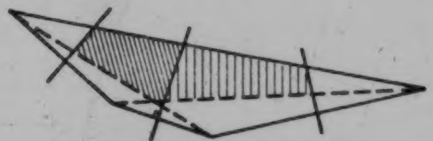
6.4 Choice of an Optimization Criterion

An obvious question remains - what is our optimization criterion? Rhind (1975, p. 297), in reviewing spatial interpolation techniques, states his ignorance of any "...fundamentally sound, cheap and easily-applied partitioning theory". He does however, mention an Israeli firm's approach of a single pass through the lattice to minimize the total length of the triangle sides, as well as a commercial package (SCA, 1970) which use the "...best overall approximation to equilateral triangles" (Rhind, 1975, p. 297). Gold (1976a) similarly optimizes by choosing the partition of the previously mentioned quadrilateral with the shortest diagonal. This however proves to be somewhat unsatisfactory as triangles with an unnecessarily small height could sometimes be produced. A more satisfactory criterion turned out to be the maximization of the minimum triangle height. This height is measured perpendicular to the diagonal bisecting the quadrilateral. Thus two heights are obtained for a given partition of the quadrilateral, and the smallest of these is retained. This height is then compared with the equivalent figure for the alternative partition of the quadrilateral, and the final partition chosen is the one having the largest value for this minimum height. Fig. 19a illustrates the difference between this and the shortest diagonal criterion. The minimum diagonal criterion produces the left-hand triangle: however, the height of this triangle measured perpendicular to the

a) Differences between optimization criteria


minimum diagonal partition
maximized minimum height partition
minimum height

b) Imperfect optimization



c) Equivalence of criteria

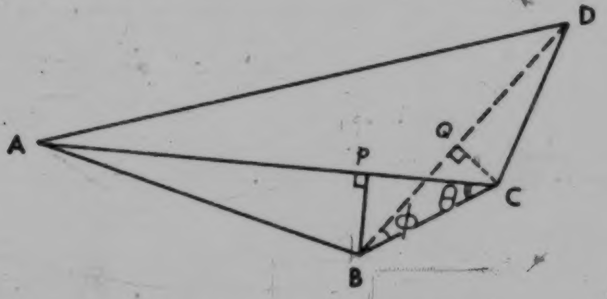


Fig.19 (From Gold et al., 1977) Optimization criteria. (a) shows the difference between two proposed criteria, (b) indicates areas for which triangulation is not optimum and (c) shows the geometric relationships between two proposed criteria.

relevant diagonal is the smallest of the four possible triangles, and hence this partition is rejected when the maximized minimum triangle height criterion is used. Lawson (1977) maximizes the minimum angle, instead of the height as is done in this work.

McLain (1976, p. 179), referring to Pitteway (1973) states that "An optimal partition is one in which, for any point within any triangle, that point lies at least as close to one of the vertices of that triangle as to any other data point." He then gives an algorithm to choose from among the candidate points. While the definition is excellent it cannot always be achieved, as shown in Fig. 19b. Whichever way the quadrilateral is partitioned, one of the shaded zones will not be "optimal" since any point within that zone will be closer to a data point outside the triangle in which it occurs than it will be to any data point forming a vertex of the containing triangle. Thus any point in a shaded zone is closer to a "bad", or undesirable, data point than it is to any "good" data point. The worst possible situation occurs at points P or Q in Fig. 19c, at the closest point in the shaded zone to the "bad" data point.

With this situation in mind Pitteway's optimal partition may be rephrased as an optimization criterion. This is defined as minimizing the ratio of the distance to the closest "good" point over the distance to the closest "bad" point, measured from the worst-case position in the triangle. If the closest "good" points for P and Q are C and

B respectively then the relevant ratios are PC/PB and QB/QC, or cot θ and cot ϕ respectively. Since sin θ = PB/BC and sin ϕ = QC/BC it is clear that maximizing the minimum height (i.e. choosing the larger of PB or QC) fulfills the theoretical optimization criterion. If the nearest "good" point is not on the suggested diagonal then PC and QB form upper limits to PD and QA, again fulfilling the required optimization criterion (Gold, 1977).

It is, of course, sometimes advantageous to modify or build the triangulation by hand. This provides the facility to modify the surface on the basis of additional information, such as continuity of valleys and ridges, which is normally difficult to build into the mapping program. A good description of this problem under the heading of "surface specific points" is contained in Peucker (1972).

6.5 Mapping with Triangular Elements

Once the data structure has been generated, its benefits in contour mapping, for example, become apparent. The problem of identifying the neighbouring data points for any arbitrary location is readily solved. Its three immediate neighbours form the vertices of the circumscribing triangle and, if desired, the three additional vertices from the three adjacent triangles may be included. This approach forms a very happy combination of the requirements for neighbours to be both close to and surrounding the point under consideration. If a simple contouring method is sufficient, each triangle may be considered to generate a function consisting of a plane passing through the three data points, as in Bengtsson and Nordbeck (1964). The surface made up of the set of triangular planes is readily contoured, there is no difficulty defining the domain in which a given set of data points define the surface, and the resolution of the final map is a function of the local data point density. The surface is, of course, discontinuous in the first derivative across triangle boundaries and its contour lines are therefore angular. For many applications, especially where the data point distribution is very dense and/or the final product required is the elevations at the nodes of a grid, this is an extremely efficient technique.

Alternatively, conventional contouring techniques could be used to produce a grid of values, merely using the triangular element data structure for collection of neighbouring data points. This would, however, neglect several advantages of the triangle approach. Therefore, in this work a method has been devised to interpolate within a triangle using the local coordinate system of Fig. 16a. In this approach, the first step is to estimate a best-fit plane, (constrained to pass through the data point), at each datum location. The surface is then estimated for each triangular domain in turn using only the three planes at the vertices. These three planes may be expressed in a form compatible with the triangular coordinate system as E_{ij} , the elevations of each of the three planes i at each of the three vertices j (Gold et al., 1977). If field measurement of the slope at data points is available (for example with dipmeter readings from drill holes) this may be used instead of the estimated best-fit plane. Use of slope information greatly increases the information content of the surface. It is suggested in McLain (1974) that the use of x and y slopes as well as the elevation information at n data points is approximately equivalent to 2.5n data points with elevations alone. This approach was also used in the SURFACE II contouring package (Sampson, 1975), although in both cases interpolation was made onto a square grid.

6.6 Requirements of an Interpolating Function

Within each triangle an equation can be developed using the local coordinate system and the nine values E_{ij} for a surface possessing certain specified properties. These properties are similar to the surface properties for any contouring method. The first is that the surface passes through the three data points - a condition not met by many moving average and gridding methods. The surface should also possess the measured or estimated slope at each data point. This condition is rarely met in conventional contouring programs, and with moving average techniques the slope at data points may be zero. It follows from this that extrema should be free to occur between data locations. This is the case with global polynomial methods, although the values may be unreasonable. The SURFACE II program, (Sampson, 1975) achieves flexibility of extrema locations by weighting the estimate produced by a best-fit plane at each data point. A fourth requirement is that the surface is continuous between domains, or regions of the map in which a specific function is used to interpolate the surface. For triangulation techniques this domain is obviously defined as the triangle. For conventional methods the definition is less obvious, but in fact it is the region of the map where a particular set of "neighbouring" data points are used to estimate the surface. Failure to give a point a zero weight before it leaves this set results in unexpected breaks in the surface and kinks in the contour lines. A last requirement is that the slope of the surface is continuous between domains, providing smooth contour lines across domain boundaries.

6.7 Shape Functions

Several attempts have been made to meet all these criteria, especially those of continuity of slope. Suggestions for obtaining an interpolated elevation estimate by weighting each of the three planes at the vertices of the triangle by the square of its associated local coordinate (r-value) (Gold, 1976b) or weighting a quadratic curve at each vertex by r^3 (McLain, 1976) have been made. Both claimed that the slope of the interpolated surface did not change abruptly when triangle boundaries were crossed, and in both cases this appears to be incorrect for reasons given by Zienkiewicz (1971, p.175). Differentiation of either

Gold's or McLain's equations in Cartesian coordinates, although tedious, clearly shows the misconception. For example, the function slope at edge 1 of a triangle is indeed independent of the coefficients of the plane or quadratic surface associated with the opposing vertex 1. However, the function slope is not independent of the location of this vertex since the weighting functions used on the remaining two surfaces associated with vertices 2 and 3 are dependent on the local coordinates r_2 and r_3 which have been shown previously (equations [6.1] and [6.2]) to involve the values x_1 and y_1. If moving vertex 1 changes the slope at and perpendicular to side 1 then clearly slope continuity cannot be expected when passing into the adjacent triangle. The effect is particularly marked when angle 2 or angle 3 of the triangle is obtuse. If a function (in this case surface slope) is to be continuous across triangle boundaries it must have no dependence on any property that differs between the two triangles. Thus slope continuity can be achieved only when all slope directions at the boundary are free of all properties of the opposite vertex - vertex 1 in this example. This cannot be achieved by any simple weighting of vertices by local coordinates since the weighting at the boundary depends on the location of the opposing vertex. This is briefly discussed in the Errata to McLain (1976).

A more helpful approach is to look at the work done on finite element analysis in engineering. Zienkiewicz (1971) and Irons (1969) are particularly useful, the first of these authors giving a relatively straightforward "shape function" which is used here. This function can be expressed as

[6.5] $Z = \sum_{i=1}^{3} \sum_{j=1}^{3} w_{ji} \; E_{ij}$,

although not used in this form by Zienkiewicz. Here Z_p is the elevation of the surface at an arbitrary location p and the E_{ij} are the coefficients of the planes associated with the vertices of the triangle, as defined previously. If $i \neq j \neq k \neq i$ then

[6.6] $w_{ji} = r_i^{2} r_j + 0.5 r_i r_j r_k$, and $w_{ii} = r_i - w_{ij} - w_{ik}$

where i, j and k refer to the three local coordinates. r_k is used here instead of $1 - r_i - r_j$ in order to preserve the symmetry of the operations performed using homogeneous coordinates.

This function possesses the correct slope at data points but does not necessarily provide continuity of slope across triangle boundaries. Zienkiewicz, however, suggests an empirical remedy. If an assumption is made about the slope normal to a side at the mid-point of that side, then the function may be corrected to conform to this. Thus S_i may be defined as the difference between the function slope (perpendicular to the boundary) and the average of the slopes of the two planes associated with that side, and v_i as a function having zero value or slope at sides j and k and unit slope at the mid point of side i. Here

[6.7] $v_i = 4(1+r_i) r_i r_j^{2} r_k^{2} / (r_i + r_j)(r_i + r_k)$.

Addition of $\sum_{i=1}^{3} v_i S_i$ to the previous function will provide the necessary slope continuity. Other assumptions can be made about the mid-side slopes, producing a variety of adequate shape functions.

6.8 Contour Mapping with the Interpolant

The surface thus produced is continuous, and is continuous in the first derivative, across all triangle boundaries. In order to plot the surface, each main triangle is divided into N^2 equal sub-triangles and Z_p calculated at each node. Linear interpolation of contour segments within each sub-triangle is straightforward since no saddle-point problem exists once the basic triangulation has been defined. The resolution of the resulting map is a function of N and the local data point density. Using this approach a contour map was produced (Fig. 20) of the strength of the vertical component of the earth's magnetic field, sampled at 26 sites in Alberta (Bannister, 1977). Fig. 21a shows a plot of sin(x)sin(y) where slopes are known at the data points. Fig. 21b is the resulting plot when slopes must be estimated, as is usually the case. Apart from boundary effects the results agree quite well. These figures illustrate the satisfactory performance of the smooth interpolating function under real as well as mathematically defined conditions.

It is of interest to compare the results of the triangulation method with contour maps produced using the grid approach. Fig. 22 shows the bedrock surface of the

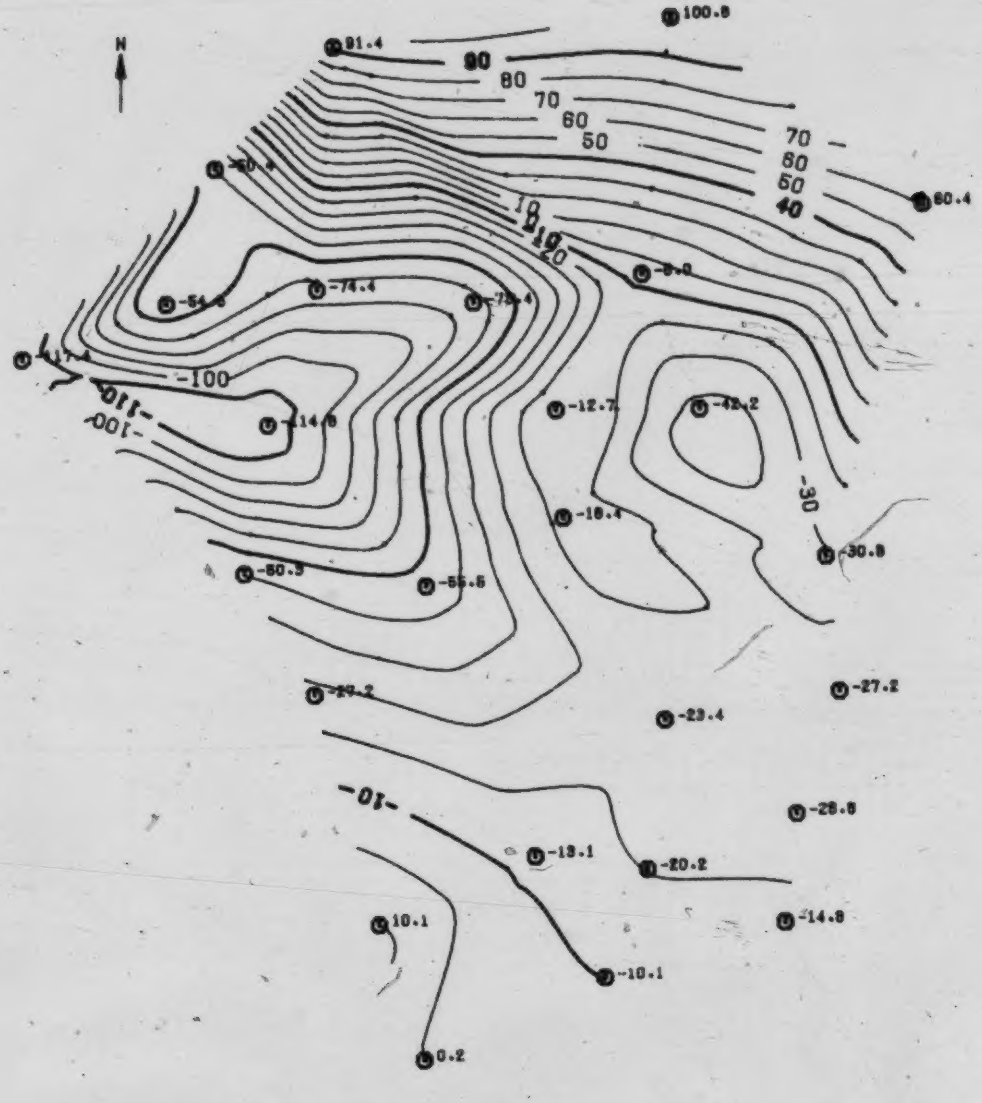
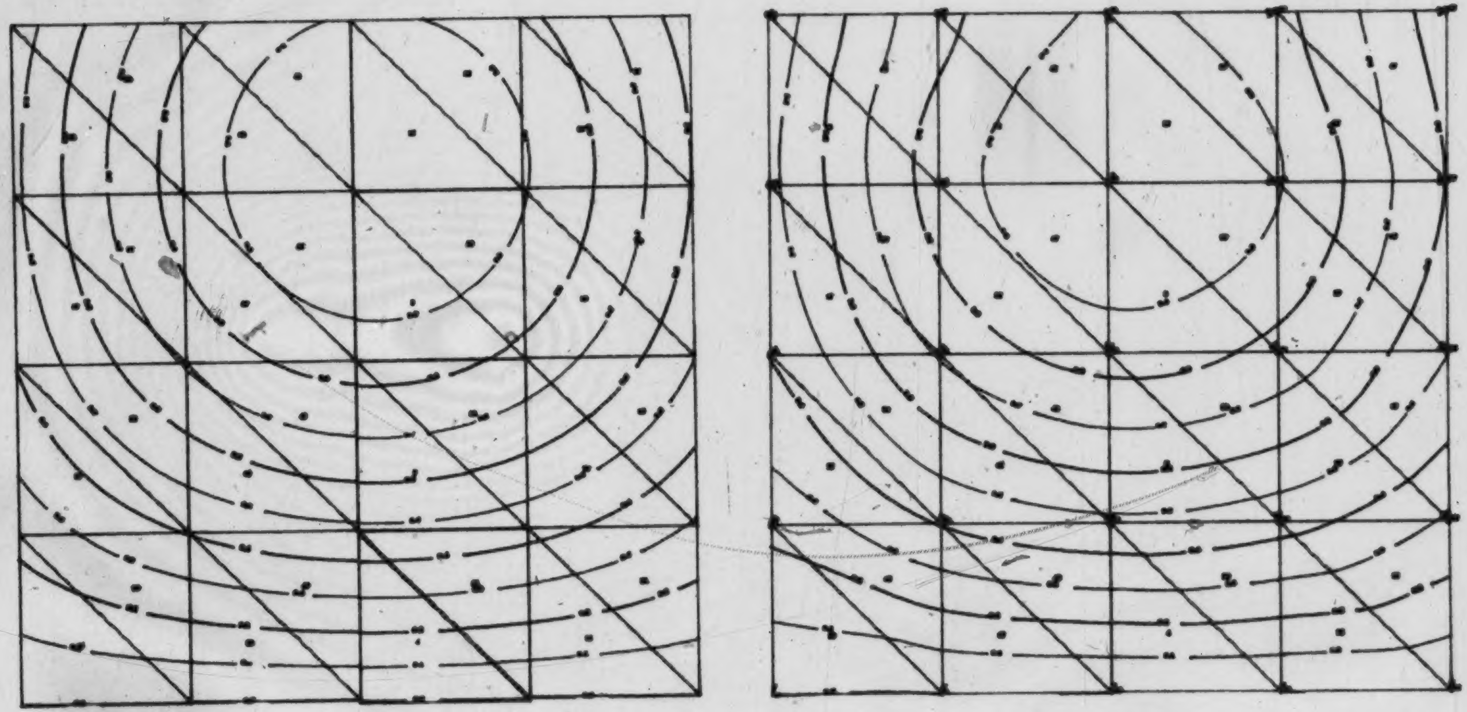

N
91.4
100.8
90
80
70
60
50
70
60
50
40
80.4
-50.4
10
0
20
-6.0
-54.6
-74.4
-75.4
-117.4
-100
-110
-100
-114.8
-12.7
-42.2
-30
-16.4
-30.8
-60.3
-56.6
-27.2
-27.2
-23.4
-10
-28.8
-13.1
-20.2
10.1
-14.8
-10.1
0.2

Fig. 20 (After Bannister, 1977) An example of triangulated contour mapping - a magnetic field map.



a) Known slopes at vertices

b) Estimated slopes at vertices

Fig. 21 (From Gold, 1977) Plot of $Z = \sin(X) \sin(Y)$

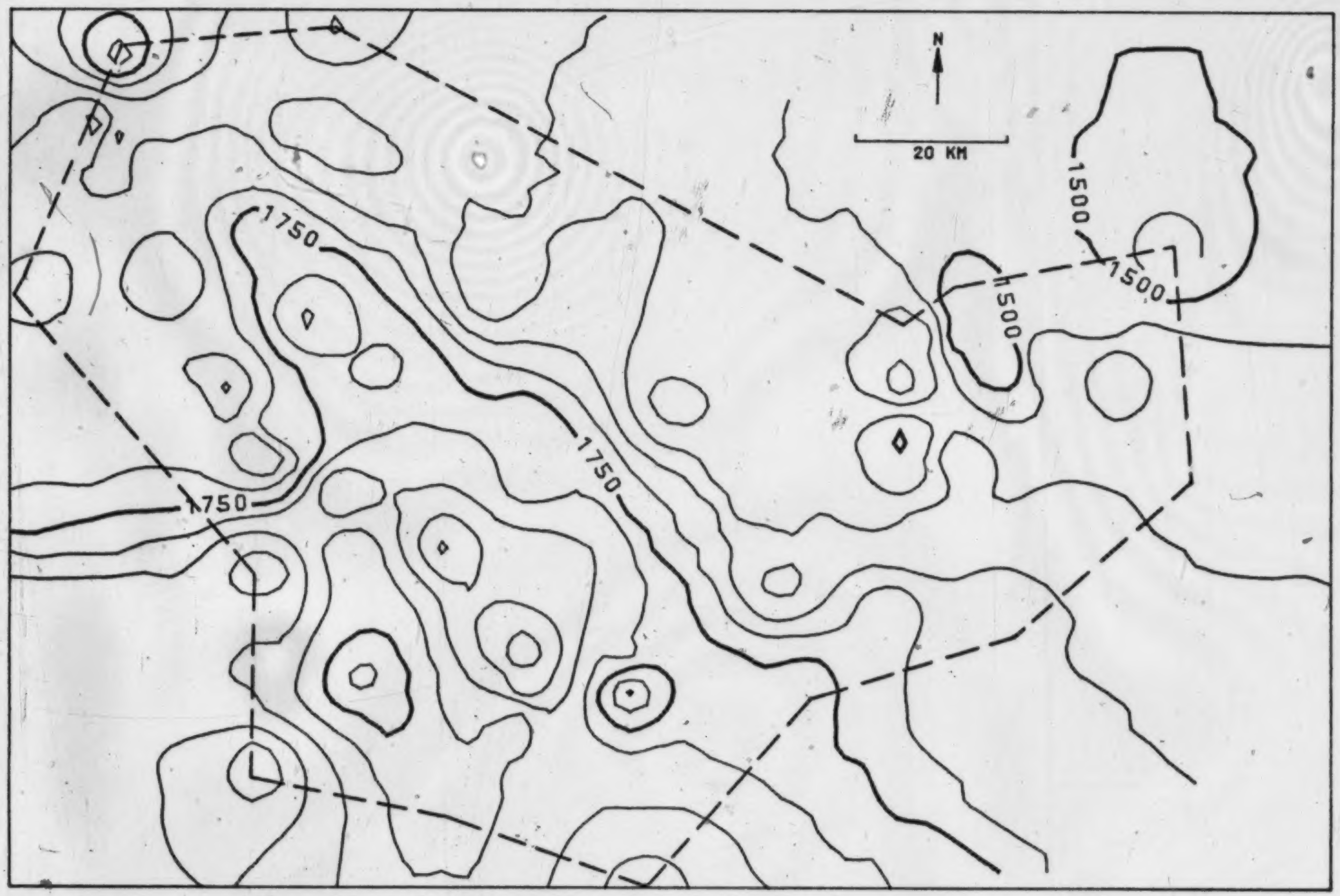

N
20 KM
1500
1500
1500
1500
1750
1750
1750
1750

Fig. 22 Bedrock surface elevation in the map area, contoured using gridding and distance - weighted elevations at data points. (50 ft. contour interval).

study area produced by the SURFACE II contouring package, (Sampson, 1975) from the 78 drill hole data points used in this study. Seven of the drill holes used (434E, 725E, 765E, 809E, 952E, 965E and 774E) were not drilled to bedrock and hence the bedrock elevations at those locations were estimated visually from neighbouring data points. A 50 by 50 grid was used in association with $1/d^2$ weighting of a fixed number of nearest neighbours tc each grid node. Fig. 23 was produced in a similar fashion, but weighting the elevation estimate derived from the best fit plane at each data point. Fig. 24 shows the same data contoured using the method developed here. If these maps are compared with the hand drawn map of Fig. 25 which is based on human interpretation as well as additional information it will be seen that the triangulation method delineates the three major channels much better than the grid approach. Although the hand drawn map takes advantage of judgemental data not readily quantifiable for computer use, the major features are partly resolved by the triangulation of the 78 data points alone. There are, however, still several "bridges" where the data point distribution imposed a triangulation forcing a ridge to cross what is in reality a valley. This is the traditional saddle point problem in a different form, and these occurrences define regions of inadequate sampling for the features to be resolved. However, if a hand generated triangulation is defined, based on the additional human knowledge (Fig. 26), then the surface may be forced to

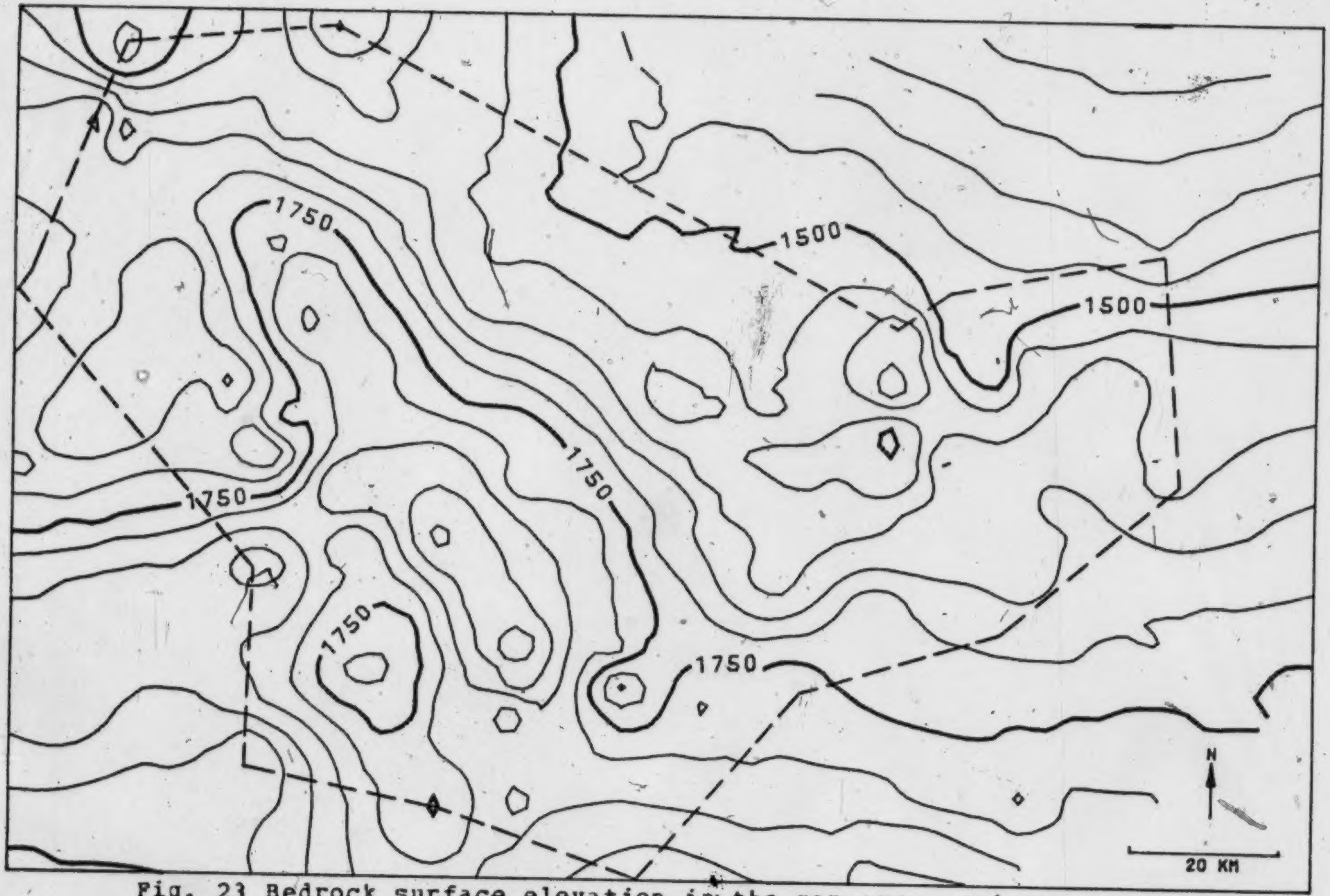

1750
1500
1500
1750
1750
1750
1750
N
20 KM

Fig. 23 Bedrock surface elevation in the map area, using gridding and distance - weighted best - fit planes at data points. (50 ft. contour interval).

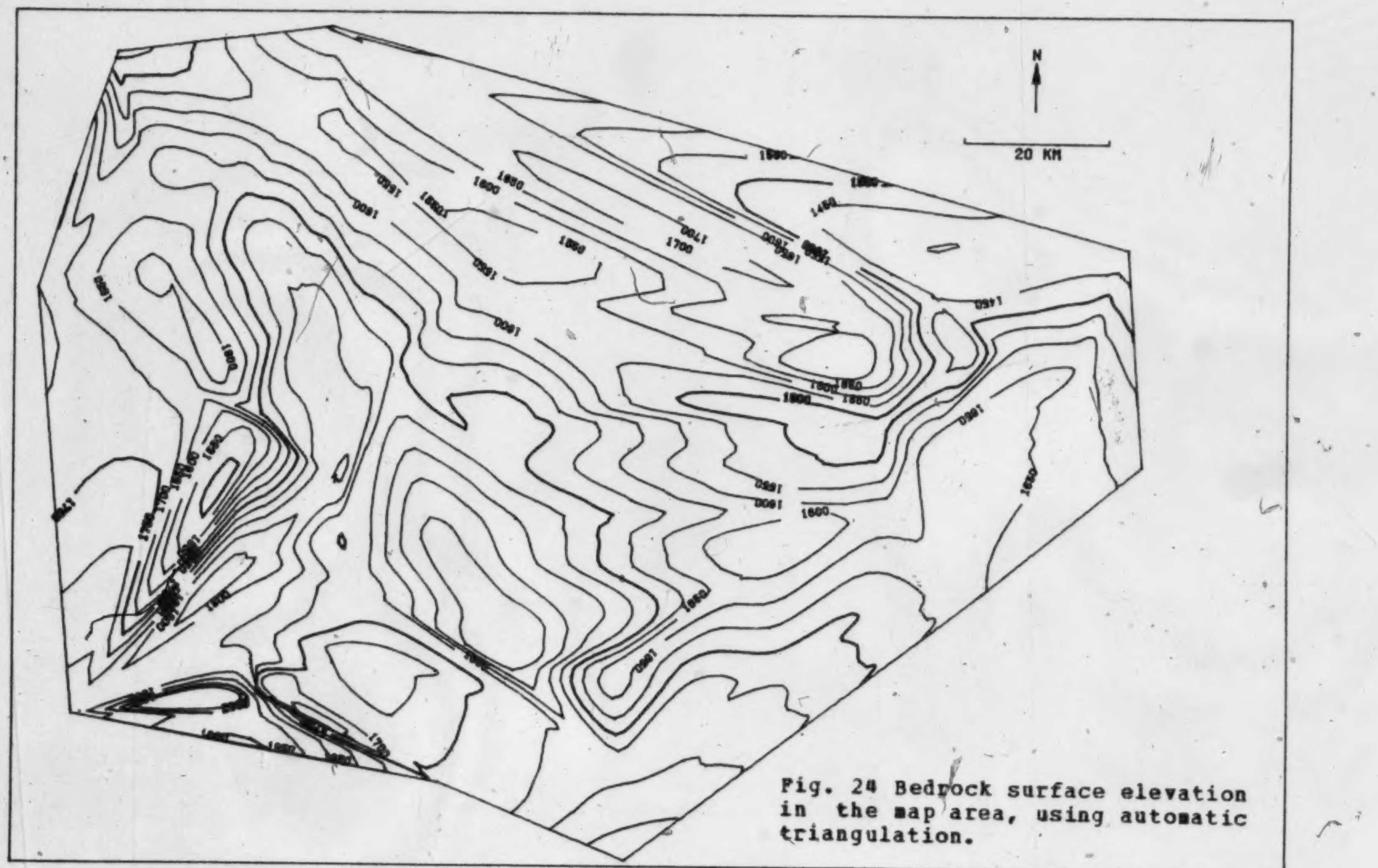

N
20 KM
1500
1550
1600
1650
1700
1800
1460

Fig. 24 Bedrock surface elevation in the map area, using automatic triangulation.

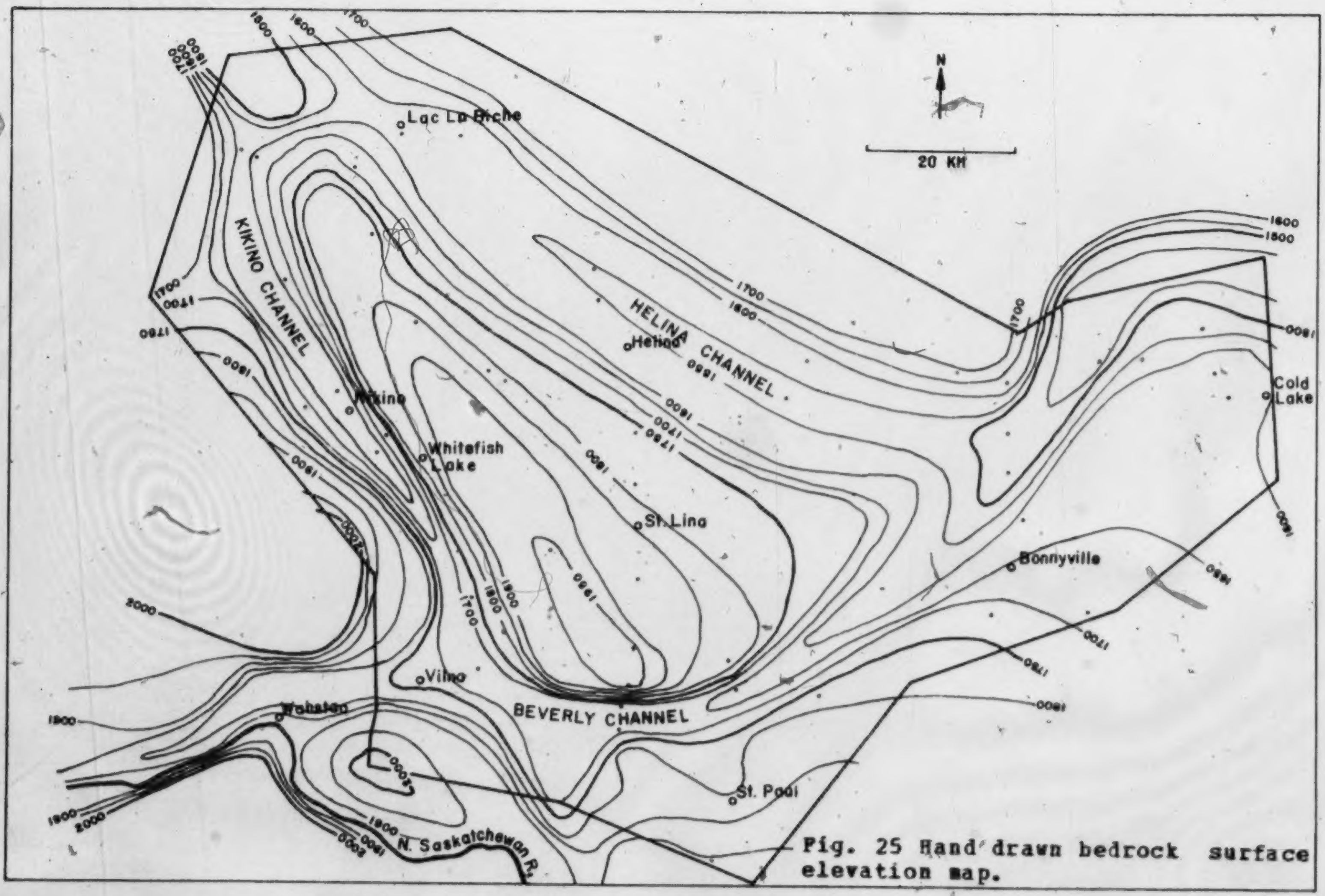

N
20 KM
Lac La Biche
Kikino
Whitefish Lake
Helina
St. Lina
Vilna
Webster
St. Paul
Bonnyville
Cold Lake
KIKINO CHANNEL
HELINA CHANNEL
BEVERLY CHANNEL
N. Saskatchewan R.
1600
1700
1800
1900
2000

Fig. 25 Hand drawn bedrock surface elevation map.

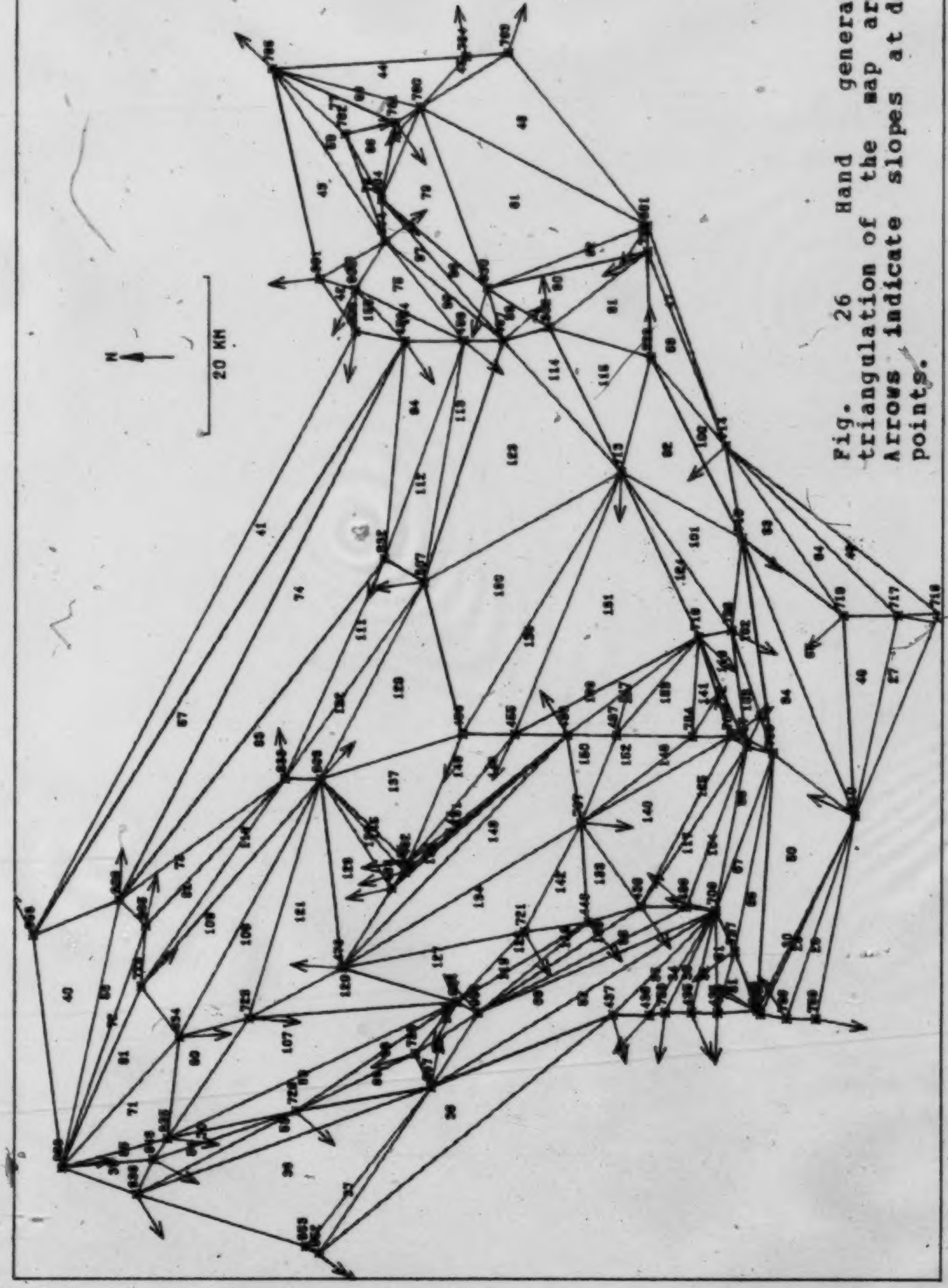


Fig. 26 Hand generated triangulation of the map area. Arrows indicate slopes at data points.

conform to the predetermined interpretation (Fig. 27).

This approach is closely related to the idea of surface specific lines expressed in Peucker (1972). Surface specific points were defined as points that furnish more information than merely their coordinates, such as peaks, pits and passes. Surface specific lines consist of ridge and valley lines, and connect surface specific points, ridges connecting peaks and valleys connecting pits. Passes are formed at the intersection of ridge and valley lines. This writer knows of no method for analytic definition of ridge and valley lines, and hence these must currently be identified by the operator and either inserted into the program or added to the map at a later stage.

At least one commercial organization (SCA, 1970) is known to use triangulation techniques for contour mapping but details of its methods are proprietary and hence remain unknown to this writer. No account is taken of the problems of surface specific lines.

6.9 Extension into Higher Dimensions

McLain (1976) suggests the possibility of interpolation in higher dimensions but unfortunately the author has found no interpolating function that guarantees slope continuity between domains. Simple planar interpolation however is both useful and direct: it is necessary merely to generalize the mesh construction for higher dimensions, and a method is proposed below. Harbaugh and Merriam (1968) generated

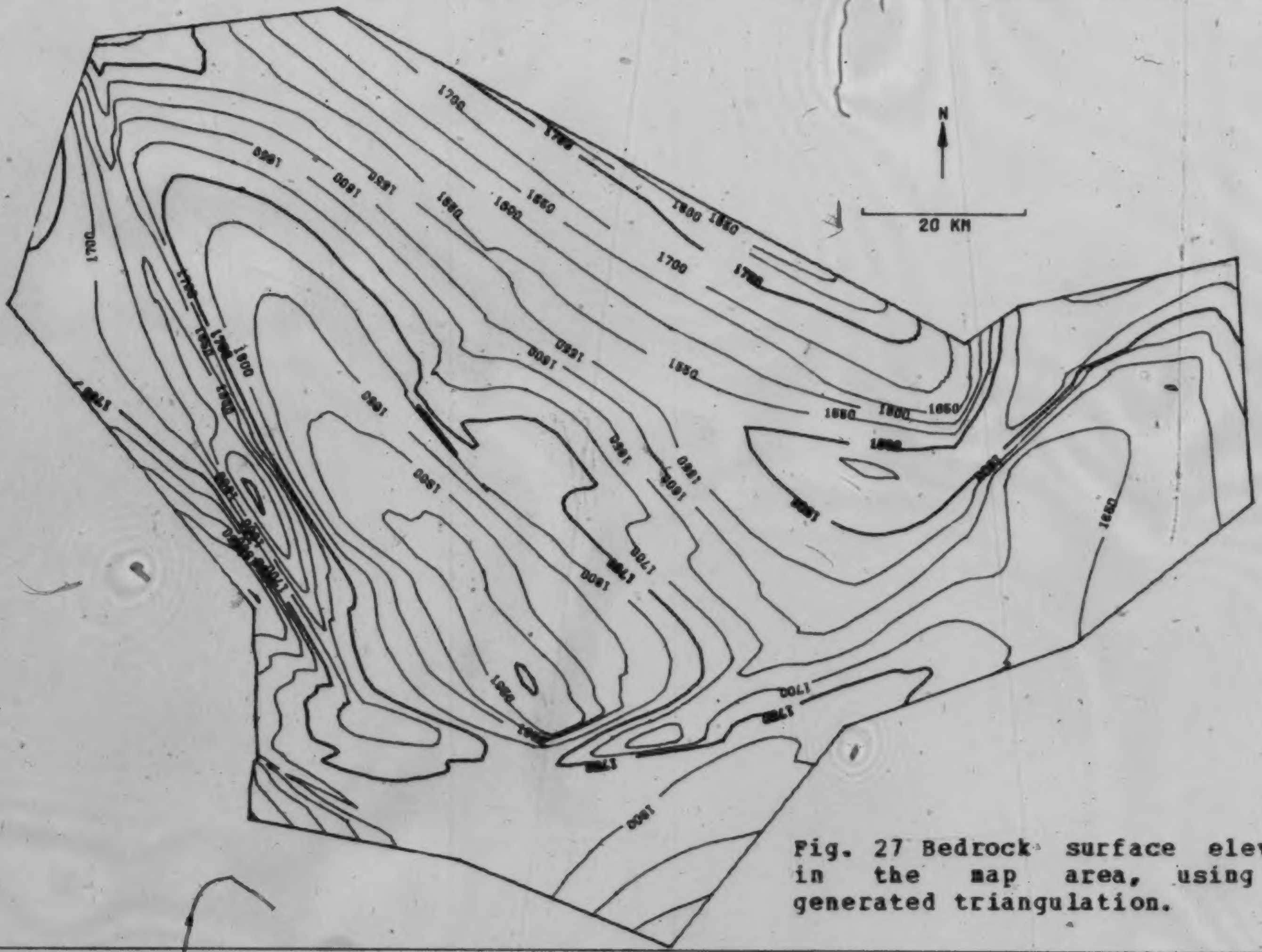

N
20 KM
1700
1650
1800

Fig. 27 Bedrock surface elevation in the map area, using hand generated triangulation.

hypersurfaces by performing trend surface analysis on crude oil gravity values from samples with locations given in three dimensions. Similar applications concerned with contouring the copper concentration in an orebody, for example, could be of geological interest.

In n-dimensional space a simplex (i.e. the simplest polyhedron of that dimension) has n+1 vertices and hence n+1 local coordinates, each involving n+1 order determinants. Insertion of new data points into a universal simplex is therefore direct. Optimization of the data structure, however, has to be rephrased. An adjacent pair of n-dimensioned simplices will have n vertices around their common face, and two independent vertices. The alternative structure is to connect these two independent vertices, producing n simplices around this central axis like the segments of an orange. This alternative is only possible if the simplex pair is convex.

If this condition is met the optimization choice is between the simplex pair and the n-simplex "orange", and either set may be switched to the other on the basis of the maximized minimum height optimization criterion. It is interesting to note that maximizing the minimum height is one of the few possible criteria in higher than 2-dimensioned space, since minimizing the diagonal is meaningless and maximizing the minimum volume is of little benefit when the number of simplices is not the same for both alternatives.

7.0 LABORATORY RESULTS

7.1 Differentiation of Till Units

Appendix 4 contains diagrams of each drill hole in the map area. In the centre of each diagram is a reduced copy of the electric log for that hole, with broad descriptive categories of the material, as well as the location of oxidized zones, in the left part of the central column. The calcium carbonate equivalent and bulk chemistry of the silt+clay fraction are expressed as histograms to the right. The far left shows the grain lithology results, and the near-left the grain size figures. These last are displayed by plotting (from right to left) a dark line for the 10 to 20 mesh fraction, a gap for the 20 to 40, a line for the 40 to 60 fraction, another gap for the 60 to 140, another line for the 140 to 230 mesh size fraction, a gap for the silt and a line for the clay fractions. In this fashion much of the information needed to distinguish the various till units is assembled in one place. The most important additional property, lateral continuity, was incorporated by extensive correlation between drill-holes, using the properties displayed in Appendix 4 as aids in matching till units.

Examination of the plots in Appendix 4 indicates the presence of at least three tills. An upper till (till 1) of moderate (3-6%) carbonate content covering the whole map area is underlain in the eastern part of the map area by a till of higher (5-10%) carbonate content (till 2). Although readily identifiable locally as moderate or high carbonate tills, these terms vary in meaning across the map area, all tills being higher in carbonate to the east. As was found in Saskatchewan (Christiansen, 1972b), carbonate content was the most useful index for till differentiation. Other properties, for example Ca, Mg and acid igneous sand grains, were closely associated with carbonate content. Additional variables were occasionally helpful in indicating till boundaries.

An oxidized zone directly below the upper till was observed in one-third of the drill-holes. It thus seems possible that sufficient time elapsed between the two glaciations for extensive weathering and/or soil development to occur. Oxidation of tills by groundwater action does occur but in the study area it appears to be sporadic, bearing little relation to compositionally-defined till boundaries. Such oxidation is usually associated with highly permeable zones within the surficial deposits. Additional evidence for the presence of a soil includes an oxidized zone between two tills, frequently in the absence of highly permeable material; the persistence of the zone at one stratigraphic position and the presence of a similar zone, interpreted as a weathered surface, in nearby areas of Saskatchewan (Christiansen, 1972b).

Underlying these two tills, but lacking any evidence of extensive weathering at its surface, the lower till has a low (1.5-5%) carbonate content and extends throughout the map area. In the eastern part the electric logs suggest that it may be divided into two units (tills 3 and 4), although this distinction is not clear on the basis of its chemistry. Glacial or preglacial deposits may separate this till from the underlying bedrock shale or sandstone. The "Saskatchewan gravels and sands" (or "Saskatchewan gravels") are well described by Stalker (1968). They include many preglacial sand and gravel deposits in Alberta, but the important feature is that they are fluvial, lie unconformably on bedrock and can be shown to be nonglacial by their lack of igneous material derived from the Canadian Shield, their abundance of chert derived from the Cordillera and, except when located close to the Cordillera, by the absence of readily weatherable mineral species. Their presence in bedrock valleys is usually considered to confirm their preglacial origin. In this study, since interpretation is based exclusively on drill hole information, the presence of lithologically similar material at the base of a bedrock valley is considered to suggest a preglacial age for the valley . The presence of any Shield material in a clean sample of otherwise typically preglacial material would strongly suggest the later reworking of the preglacial deposits. While it is true that slumpage in the drill hole may introduce such material from above, a similarity of grain sizes for both the preglacial and shield material would suggest that they were, in fact, mixed prior to their being disturbed by drilling. In the plots of Appendix 4 the suggested till units are marked in the right half of the central column. The upper till is labelled 1, the middle till 2, the upper member of the lower till is labelled 3 and the lower member 4.

7.2 Relation of Analyses to Till Units

The four till units suggested were distinguished on the basis of a wide range of properties, including their composition. At least some of the measured variables should therefore vary significantly between some of the tills. While this may be confirmed by visual inspection on a hole by hole basis for some variables, any general statistical test, runs into at least two problems with respect to sample location. Firstly, sample composition within a till varies appreciably and somewhat systematically over the map area. Carbonate content, for example, is likely to be lower in the western part of the map than in the east, whichever till is being considered, and hence it is unreasonable to compare directly samples from differing map locations. The second problem is that two of the units, the middle till and the lower part of the lower till, have only been identified in the eastern part of the area, thus biasing their compositional estimates if compared with units possessing better sample coverage.

In an attempt to minimize this problem, analysis of covariance was performed on each analyzed variable in turn, using the ANOVA program available in the SPSS package of statistical programs (Nie et al., 1975). In this a one-way analysis of variance is performed to determine if the analyzed variable varies significantly between any of the four units, but at the same time the sample's location is incorporated in the analysis as two covariates (distances east and north in metres UTM coordinates). These covariates are first applied to explain as much of the variation as possible and the analysis of variance performed on the residual variance. Linear regression procedures are used on the raw data to remove variation due to the covariates, and thus more complex variations in composition with location are not considered. Nevertheless at least some of the bias due to location has been explained. These analyses are shown in Appendix 5. The variables were found to vary significantly at the 5% level between the four till units in all cases except the 20-40, 40-60, 60-140 mesh and total sand fractions.

If some of the variables differ significantly between till units, it is of interest to ask which variables differentiate which till units. Table 8 shows the grand mean for each variable and the mean for each till unit, corrected for location and expressed as deviations from the grand mean. These values are rank ordered with the unit expressed as a superscript from 1 to 4, as in Appendix 4. Duncan's "new multiple range test" (Steele and Torrie, 1960, Section 7.5) has been applied to them, and those means found not to be significantly different at the 5% level have been

Variable	Grand Mean	Unit Means			
Sand 10-20	3.13	$-.18^{3}$	$-.03^{1}$	$.27^{4}$	$.44^{2}$
Sand 20-40	5.35	$-.10^{2}$	$-.03^{1}$	$-.01^{3}$	$.41^{4}$
Sand 40-60	8.74	-1.27^{2}	$-.11^{3}$	$.01^{1}$	$.80^{4}$
Sand 60-140	14.73	-1.49^{4}	$-.64^{2}$	$-.06^{3}$	$.46^{1}$
Sand 140-230	5.74	$-.59^{2}$	$-.35^{4}$	$.01^{1}$	$.28^{3}$
Total Sand	37.7	-1.37^{2}	$-.74^{4}$	$-.06^{3}$	$.52^{1}$
Silt	51.37	-1.42^{1}	$.73^{3}$	1.64^{4}	2.39^{2}
Clay	10.93	-1.02^{2}	$-.89^{4}$	$-.64^{3}$	$.90^{1}$
CaCO3	6.78	-1.60^{3}	-1.27^{4}	$.13^{1}$	4.78^{2}
Local	7.07	-3.76^{2}	$-.16^{3}$	$.03^{4}$	1.08^{1}
Acid	59.18	-2.82^{4}	-2.22^{3}	$.98^{1}$	4.20^{2}
Basic	4.27	-1.33^{4}	$-.20^{3}$	$-.03^{1}$	$.89^{2}$
Carbonate	4.04	$-.62^{1}$	$.10^{3}$	$.84^{4}$	1.57^{2}
Quartz	25.44	-2.90^{2}	-1.41^{1}	2.27^{4}	2.48^{3}
Na	.31	$-.06^{4}$	$-.01^{1}$	0.0^{3}	$.06^{2}$
Mg	1.05	$-.18^{3}$	$-.18^{4}$	$.03^{1}$	$.50^{2}$
Al	7.63	$-.11^{2}$	$-.07^{1}$	$.07^{3}$	$.24^{4}$
Si	33.11	$-.96^{2}$	$.03^{4}$	$.05^{1}$	$.27^{3}$
K	2.04	$-.03^{3}$	$-.03^{4}$	$.01^{1}$	$.06^{2}$
Ca	2.91	$-.35^{3}$	$-.19^{4}$	$.04^{1}$	$.93^{2}$
Ti	0.44	$-.02^{2}$	$-.01^{1}$	$.02^{3}$	$.02^{4}$
Fe	3.82	$-.05^{1}$	0.0^{2}	$.06^{3}$	$.08^{4}$

Table 8 Variation of analyses between till units. Column 2 shows the grand mean for each variable and columns 4 - 7 show the values for each unit, expressed as deviations from the grand mean. Superscripts indicate the till unit. Underlined means do not differ from each other significantly.

underlined. Table 9 summarizes which variables may satisfactorily distinguish between particular tills in this study. Thus a variable plotted in a particular cell has a significantly higher value in the till forming the column than in the till forming the row. On the right of Table 9 are shown those variables whose mean value for a till differs significantly from all the other tills, either by being high or low. Those variables in parentheses are second highest or lowest in Table 8. It can be seen that all till units may be distinguished on the basis of composition, but the lower member of the lower till only differs from the upper member by having a somewhat coarser sand texture and a higher Al content.

7.3 Relationships between Analyzed Variables

Clearly the behaviour of some of the variables in Table 9 is similar to the behaviour of other variables. It would be of value for future work to determine which analyzed variables group together and hence which ones are redundant. Cluster and factor analysis are suitable techniques for examining this problem.

Cluster analysis (Hartigan, 1975, Sneath and Sokal, 1973) is a method of partitioning an observed sample population into different classes and producing hierarchical classifications of these. In this case the 22 analyzed variables themselves were considered the samples to be classified. Several different forms of cluster analysis

	Unit with Higher Value			
Unit with Lower Value	1	2	3	4
1		S1020 Silt CaCO3 Acid Basic Carb Na Mg Ca K	Silt Carb Qtz Al Ti Fe	Silt Carb Qtz Al Ti Fe
2	S60140 S140230 Clay Local Qtz Si		S140230 Local Qtz Al Si Ti	S4060 Local Qtz Al Si Ti
3	Clay CaCO3 Acid Mg K Ca	S1020 CaCO3 Acid Basic Carb Mg Ca K		S1020 S4060 Al
4	S60140 Clay CaCO3 Acid Mg Ca	CaCO3 Acid Basic Na Mg K Ca	S60140 S140230	

	Variables Diagnostic for each Unit	
	Low	High
1	Silt Local Carb (Qtz)	Clay (CaCO3) (Acid) (Mg) (Ca)
2	Qtz Si	CaCO3 Acid Basic Mg K Ca
3		(Al)
4		Al

Table 9 Analyzed variables that differentiate between till units. As an example, row 1, column 4 in the left hand table indicates that Fe is significantly higher in unit 4 than in unit 1. The right hand table indicates those variables that differentiate a till unit from all others. Variables in parentheses are second highest or lowest (see Table 8).

available in the CLUSTAN package (Wishart, 1975) were performed using the correlation matrix given in Appendix 6 as the information describing the relations between variables. Figs. 28 and 29 show dendrograms produced by hierarchical clustering, in which initially each variable forms a separate cluster and clusters are grouped in order of greatest similarity. Similarity between groups may be defined in several different ways. Fig. 28 shows the result when group similarity is defined as the lowest similarity between any pairs of points, one from each cluster. Fig. 29 shows the result when the average, rather than the lowest, pair similarity is used. Fig. 30 shows the results of using the "dendrite" procedure in which the minimum spanning tree, or shortest dendrite connecting all points, (Wishart, 1975, p. 67) is broken into the desired number of clusters by eliminating the required number of connections. The linkages removed are chosen on the basis of minimizing an error sum term. A final dendrogram (Fig. 31) is produced by the "mode" procedure in which a sphere of a chosen radius is considered to enclose each data point, and clusters are defined as all those points whose spheres form a common bounding surface. The method of introduction of points and updating the sphere radius is such that at the start and finish only one cluster is present, and it has been suggested that the number of clusters present prior to the first fusion of groups represents the lowest "natural" level of classification, in this case three clusters.

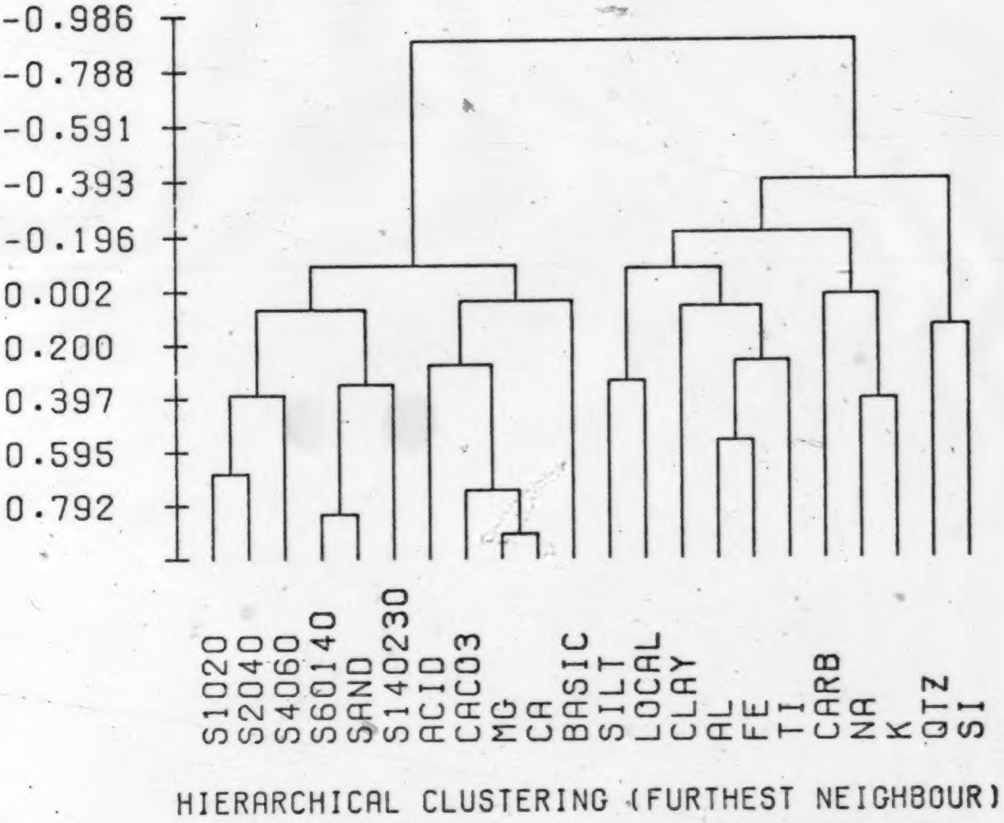


Fig. 28 Dendrogram showing the relationships between the 22 analyzed variables. Ordinate values represent the product - moment correlation coefficient.

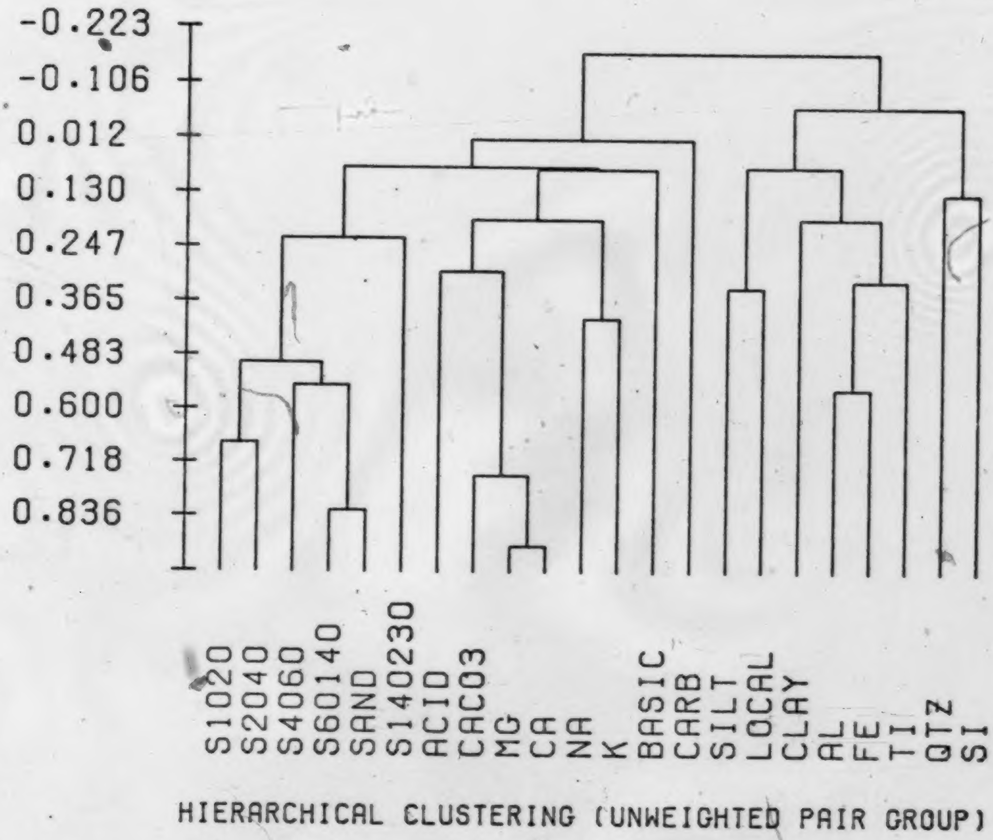


Fig. 29 Dendrogram showing the relationships between the 22 analyzed variables. Ordinate values represent the product - moment correlation coefficient.

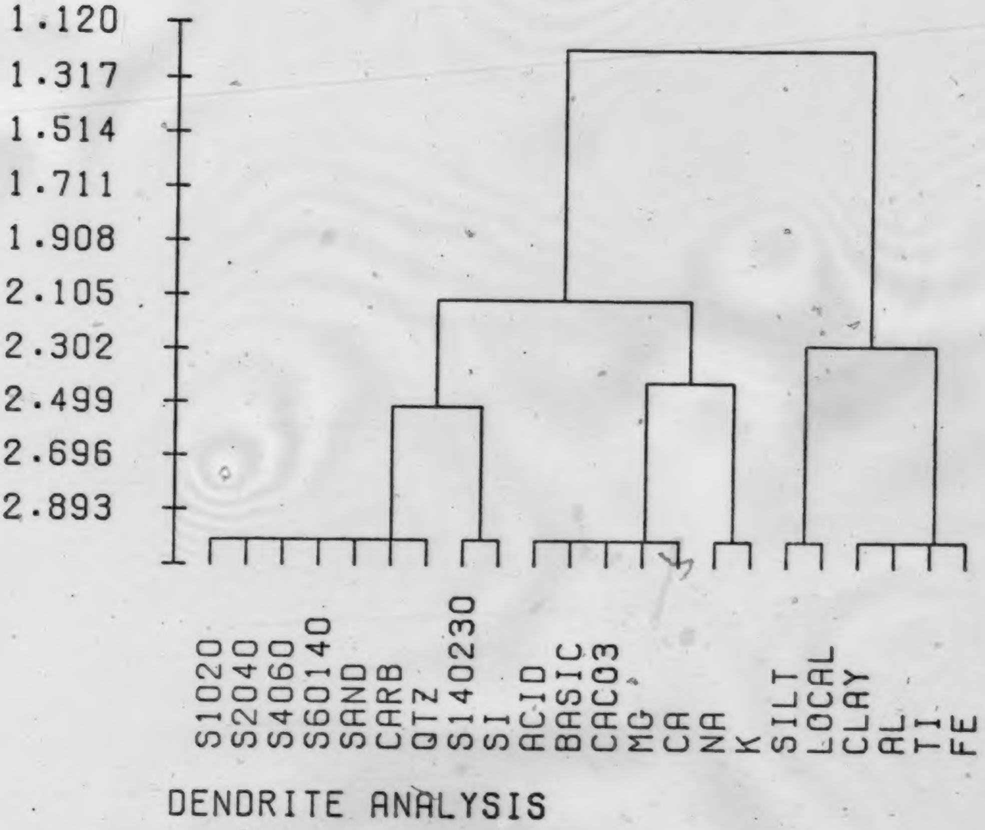


Fig. 30 Dendrogram showing the relationships between the 22 analyzed variables. Ordinate values represent the within - groups error sum of squares.

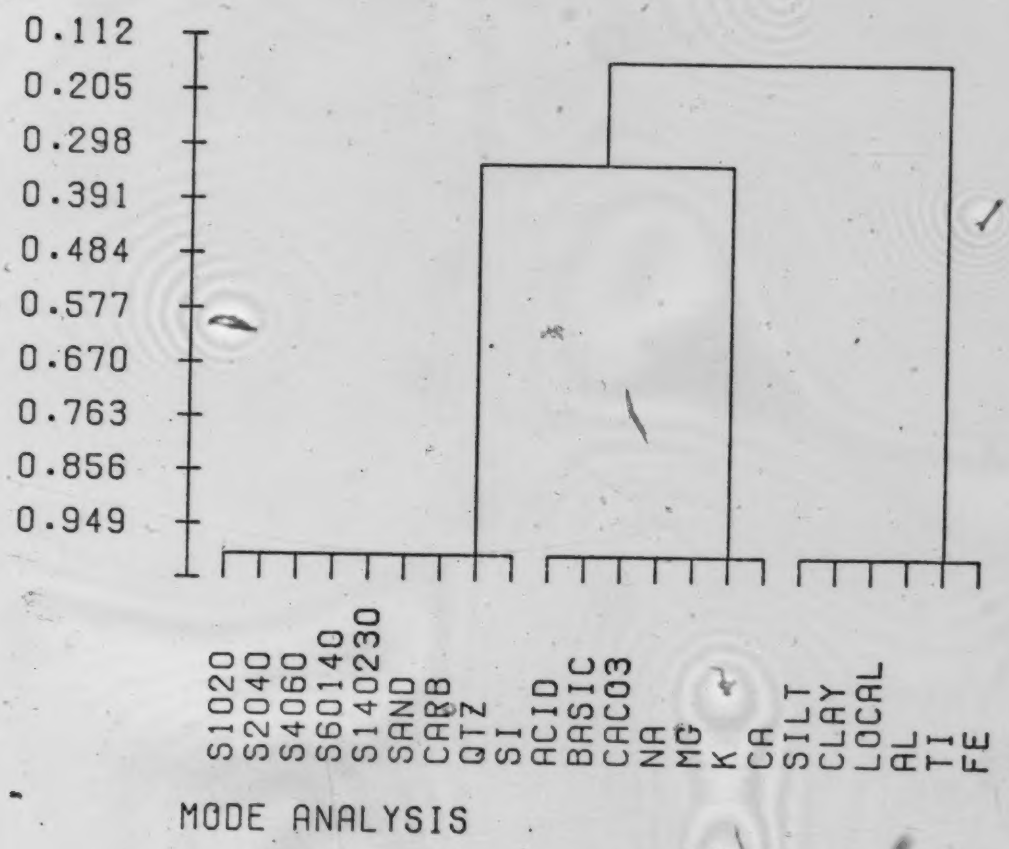


Fig. 31 Dendrogram showing the relationships between the 22 analyzed variables. Ordinate values represent the product - moment correlation coefficient.

The cluster methods illustrated all agree in general on these three major groups. Group 1 consists of all sand sizes. Carbonate and quartz grains and Si content may associate weakly with the sand sizes, but not consistently between methods. Group 2 consists of components that could be considered "erratic" in origin, possible sub- groups 2a containing Na and K and 2b containing acid and basic grains, calcium carbonate equivalent, Mg and Ca. The association of groups 2a and 2b with each other is agreed on by all except the furthest neighbour method. Group 3 consists of "local" constituents -3a consisting of silt percentage and local grains, 3b consisting of clay, Al, Ti and Fe.

Factor analysis (Cattell, 1965a,b, Harman, 1967, Kaiser, 1970) is a technique for examining a correlation matrix to determine whether its dimensions may be reduced without serious loss of information. This is achieved by creating factors or components which are linear combinations of the observed variables. The first step is to define a set of uncorrelated components that explain as much of the variation of the data as possible. The second step is to determine if any of these components are of insignificant value in explaining the data variation, and eliminating them. The third step is to rotate these components until they are associated in some fashion with groups of the original variables. Appendix 6 contains the results of factor analysis of the 22 analyzed variables, using the principal compont approach and varimax rotation.

Calculations were performed using the SPSS package (Nie et al., 1975). Although seven eigenvalues are greater than unity, a scree test (Cattell, 1966) on these suggests that a maximum of four are meaningful. Component 1 associates strongly with the sand size fractions, and negatively with the silt fraction. Component 2 associates strongly with calcium carbonate equivalent, Ca and Mg, and moderately with 10-20 mesh sand, acid and basic grains, Na and K. There is strong negative association with Si and, to a lesser extent, quartz grains. It can be related to erratic components of the till, especially the Devonian carbonates and, perhaps to a lesser extent, the igneous Precambrian shield to the northeast. Component 3 associates strongly with clay, Al, Ti and Fe, suggesting a relationship with the local shales. Component 4 associates strongly and positively with Na, K and quartz grains but moderately and negatively with Si, suggesting a possible relation to quartz grains and feldspars from the Precambrian shield to the northeast. Component 5 associates fairly strongly with carbonate and quartz grains, Component 6 with the fine sand fractions and Component 7 associates positively with acid and basic grains but strongly negatively with local grains.

A comparison with the cluster analysis results suggests that components 1,2 and 3 correspond well with cluster groups 1,2 and 3, but that there may well be a distinction between cluster groups 2a and 2b based on the source of the erratic material.

Analyzed variables may thus be classified into textural, erratic and local groups, implying that in further work fewer variables need be examined. In addition, the use of factor analysis techniques permits the derivation of composite component scores. Thus the Component 2 score for a sample may better represent the erratic component of the till than an individual variable. While such scores were not used in the visual estimation of the till unit contacts (Appendix 4) they have been used in the examination of compositional variation within a till unit.

7.4 Choice of Variables for Till Differentiation

Examination of the plots of each variable against depth suggests a question: "Which variables can one use in order to distinguish different till units within a drill hole?" On the basis of cluster and factor analysis the most useful variables are those expressing the local/ erratic proportions in the tills. Ca, Mg and calcium carbonate equivalent are obvious choices that estimate the content of erratic material . Clay content, even with the poor accuracy of analysis in this study due to long sample storage, estimates the local material content fairly well, but not as well as Al or Fe. Total sand content, although not diagnostic of any particular till units, often is useful to mark breaks in depositional continuity. Acid igneous grains are also occasionally helpful. However, for identifying till units as continuous between drill holes several miles apart, variation in the erratic component is the most useful. In practical terms, percent total sand and percent calcium carbonate equivalent are the variables most commonly used to distinguish till layers, and calcium carbonate equivalent alone is frequently adequate to correlate these units between drill holes. A good example of clearly distinguished tills can be seen in drill hole 714E in Appendix 4. It is also evident that the bulk chemistry of the till matrix (less than 63 microns in this study) exhibits a far greater degree of homogeneity within the till units than would be expected from examination of the coarser fractions.

7.5 Compositional Variation within Till Units

On the basis of the suggested till units and groupings of analyzed variables, how should the compositional variation in the tills be described? Apart from vertical variation in composition between till units there is vertical variation within till units at a given location. In addition there is the lateral variation of a particular till. Boulton and Dent (1974) describe grain size variation due to shearing and weathering in the top metre or so of an exposed lodgement till, but in the current study the variation under consideration is on a larger scale. Appendix 7 illustrates a property of the lateral variations of the analyzed components of the four till units -- it may be very large. These maps were produced using the triangulation techniques described earlier. If lateral variation is indeed larger than vertical variation on a regional basis, then a natural question concerns the local area over which lateral consistency is observed, since some lateral consistency must exist in order to permit the observation of vertical till homogeneity. A final question concerns the similarity of behaviour, or lack of it, between the different analyzed components of the till.

7.6 Vertical Variation in Till Composition

Hole number 714E was chosen to illustrate the vertical variation in till composition, since three well-sampled till units were identified in it. The middle till (unit 2 in the analysis of variance tables of Appendix 8) was sampled 19 times, the upper member of the lower till (unit 3) was sampled 13 times, and the lower member of the lower till (unit 4) eight times. Appendix 8 contains the results of a one-way analysis of variance performed on each of the 22 analyzed variables, with the three till units as the classifying categories. The main question is whether the between-units variation is significantly greater than the within-units variation, in which case that particular analyzed variable may be used to distinguish between at least two of the till units found in this drill hole. Appendix 8 shows that this is the case for the 10 to 20 mesh sand, all grain counts except the basic igneous grains, calcium carbonate equivalent, and all the bulk chemical analyses. Calcium carbonate equivalent and calcium and magnesium content showed extremely high levels of significance.

In addition to the analysis of variance tables, Appendix 8 shows the mean, range and 95% confidence interval of the mean for each of the till units. From these it can be determined which tills may be distinguished using a particular analysis. The middle till (unit 2) may be distinguished quite well from both the lower tills by the 10 to 20 mesh sand, local, acid igneous and quartz grains, calcium carbonate equivalent and all bulk chemistry analyses. The upper and lower members of the lower till (units 3 and 4) may be distinguished by calcium carbonate equivalent, Mg, Si, Ca and Ti concentrations. In addition, erratic components tend to increase in concentration, and local components decrease, with decreasing age of the till unit. This is a variation between units, rather than a simple variation with depth, since for many analyses the between-units variance was much greater than that within units. Hole 714E shows compositional differences between tills better than most of the drill holes. It does however, illustrate the high possible homogeneity of the composition of a till unit throughout its thickness, especially in the fine fraction.

7.7 Local Depositional Processes

In contrast, the lateral homogeneity of till composition is far less clear, and the composition maps of Appendix 7 may show appreciable fluctuation in composition over the study area. This suggests that till forming processes were local in effect but stable throughout the period of deposition of at least the basal part of a till unit, although distinction of basal from ablation till has not been attempted in this project. Sufficient information is not available to suggest a depositional mechanism that, while only producing the same effects over short distances laterally, maintained these effects during most of the depositional period of the till. It appears unlikely that such a process would remain locally stable over extended periods of time while the flow conditions of the ice sheet changed in response to climatic and other conditions. It appears much more likely that the actual deposition of till only occurred as a single relatively short-lived phenomenon in the life-cycle of a continental ice-sheet. Under these conditions the bulk of the till unit - up to 100 ft (30m) in the case of hole 714E, and greater in some others - would have been deposited under one, perhaps very short-lived, set of local flow conditions. While deposition may have occurred more than once, under different local conditions, there is little evidence for this in the upper and middle till units, although this is a possible explanation for the weak but sometimes measurable differences between the upper and lower members of the lower till.

7.8 Lateral Variation in Till Composition

If depositional processes were involved that remained constant over only limited lateral extent it is important to examine the extent of those possibly local processes. An attempt was made to investigate this by using a suitable analysis of variance design. In addition, since some till constituents were described as being erratic components, it was necessary to determine whether they or any other analyzed variables could be considered to vary significantly between different parts of the study area.

7.9 Sampling and Statistical Model

In order to compare local and regional lateral compositional variation it was necessary to select several distinct areas of the map each containing several drill holes. In addition, if between-units variation was to be examined these drill holes should penetrate several tills, and if vertical variation is of interest, several samples should be available from each unit. Unfortunately, since computational methods become extremely complex for suitable analysis of variance designs if some categories contain no samples, the choice of test data was very limited. Consequently three areas were selected, a western one using holes 435E, 436E, 437E and 758E. A central area containing holes 456E, 498E and 709E; and an eastern area using holes

457E, 458E and 765E. Since the middle till and the lower member of the lower till appear to be absent from the west of the area, only the upper till and the upper member of the lower till were used. This was perhaps unfortunate since the middle till was compositionally the most distinctive. Finally, due to the low number of samples in some drill holes only two samples were used from each unit in each drill hole, selected from near the top and bottom of the unit.

The analysis of variance design used was a model described by Winer (1962, p. 334, Table 7.3-10). The model would have been a simple factorial design were it not for the fact that a particular drill hole clearly cannot be repeated in each of the three areas. Hence drill holes are "nested within" areas and are treated as replicates. However, the unit and position within the unit of each sample must still be accounted for and are "crossed" with each other and with the drill holes, since a sample may be found for each combination of drill hole, unit and sample position. This model is most easily defined as a single factor model (area) with replicates (drill holes) and repeated measures. These repeated measures therefore consist of the four combinations of unit and sample position. It is a property of this model (and of the data) that interaction terms involving drill holes cannot be tested and must be pooled with other terms to form the relevant error sums of squares. Thus the sum of squares due to area is tested against a pooled error sum of squares consisting of the sum of squares due to drill holes plus the interaction between drill holes and areas. This interaction has no conceptual meaning since drill holes are nested within areas. Similarly the significance of units, and the interaction between areas and units, are tested against the interaction between units and drill holes plus the interaction between units, drill holes and areas. Sample position and (area x position) interaction are tested against the (drill hole x position) plus (drill hole x position x area) interactions. Finally, the (unit x position) and (area x unit x position) sums of squares may be tested against the pooled (unit x position x drill hole) plus (unit x position x drill hole x area) sums of squares.

Appendix 9 shows the analysis of variance results for each of the 22 variables and Table 10 summarizes the significance of the relevant F, or variance ratio, tests. A particular concern is the relation between local and regional variation for each component of the till. Those analyses differing significantly between regions of the map as opposed to within regions were acid igneous grains, calcium carbonate equivalent and Ca content at the 5% level and Na at the 10% level, with Mg approaching 10% significance. Thus, although the variance analysis was performed on fewer samples than would have been desirable, it appears that only erratic constituents of the till vary more on a regional basis than a local one within a specified

	Area	Unit	Unit x Area	Position	Position x Area	Unit x Position	Unit x Position x Area
Sand 10-20	.142	.144	.012	.112	.349	.617	.183
Sand 20-40	.542	.106	.023	.088	.430	.390	.490
Sand 40-60	.274	.009	.001	.888	.611	.036	.101
Sand 60-140	.641	.366	.052	.652	.387	.692	.109
Sand 140-230	.426	.346	.988	.563	.372	.988	.467
Total Sand	.337	.135	.004	.238	.254	.331	.050
Silt	.515	.164	.001	.067	.200	.605	.584
Clay	.529	.028	.126	.553	.125	.452	.032
Local	.218	.738	.175	.743	.814	.839	.445
Acid	.037	.870	.223	.202	.555	.554	.707
Basic	.535	.761	.541	.449	.320	.806	.609
Carbonate	.990	.857	.317	.439	.566	.033	.616
Quartz	.300	.611	.221	.593	.994	.521	.895
CaCO3	.001	.191	.338	.835	.605	.115	.147
Na	.059	.906	.704	.011	.199	.482	.696
Mg	.118	.105	.775	.099	.819	.145	.113
Al	.680	.922	.321	.737	.279	.856	.113
Si	.156	.643	.723	.191	.899	.562	.844
K	.197	.433	.688	.568	.849	.888	.980
Ca	.020	.578	.634	.221	.519	.418	.281
Ti	.248	.322	.194	.124	.531	.394	.186
Fe	.854	.429	.502	.107	.334	.729	.512

Table 10. Significance levels of the factors and interactions of Appendix 9. Levels of 10% or better are underlined.

till unit. Appendix 7 shows the lateral variation in each till unit for grain size, grain count, calcium carbonate equivalent and bulk chemistry.

The till components that do vary significantly between regions of the map are those that correspond strongly with Component 2 in the factor analysis described in Section 7.3. It was suggested that this component represented erratic material introduced into the map area by the moving ice. As can be seen from the maps of Appendix 7 these same components, despite any local variations, decrease generally towards the southwest. Besides maps of calcium carbonate equivalent for each till unit, Figs. 32 to 35 contain maps for each till unit of the Component 2 scores for all samples, calculated from the factor-score coefficient matrix of Appendix 6. The score for each sample is obtained by normalizing each analysis value (by subtracting the mean and dividing by the standard deviation for that analysis), multiplying it by the Component 2 score coefficient for that analysis, and then summing these results over all analyses. In addition Figs. 36 to 39 show maps of the ratio of the concentrations of erratic cations (Na, Mg, K, Ca) over local cations (Al, Si, Ti, and Fe) that are probably derived mainly from the local sandstones and shales. Calcium carbonate equivalent, Component 2 scores and erratic ratios tend to behave in a similar fashion for a particular till unit.

Dreimanis and Vagners (1969, 1971) examined the

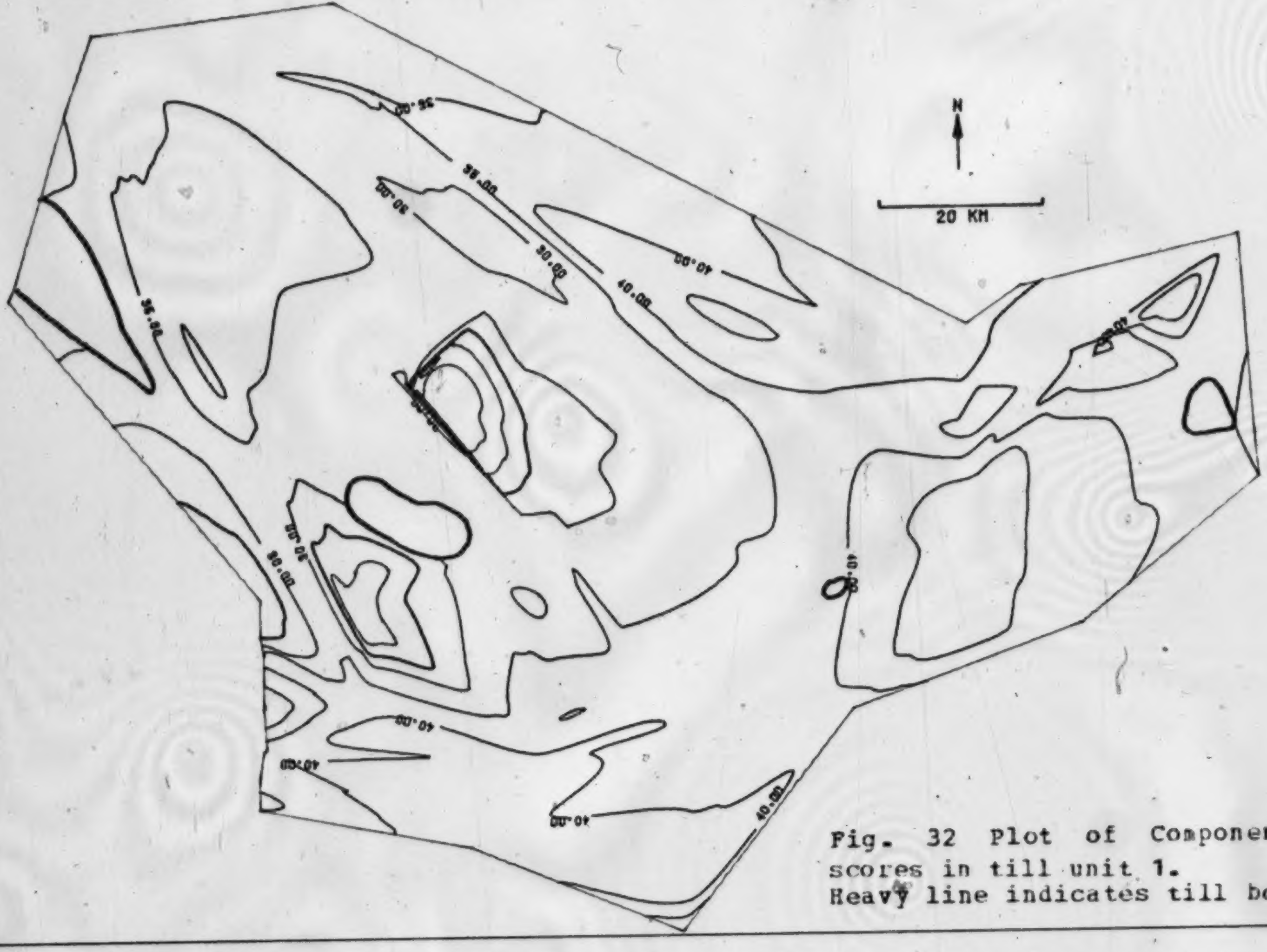

N
20 KM
35.00
35.00
30.00
30.00
40.00
40.00
40.00
35.00
30.00
30.00
40.00
40.00
40.00
40.00
40.00
40.00

Fig. 32 Plot of Component 2 scores in till unit 1. Heavy line indicates till boundary.

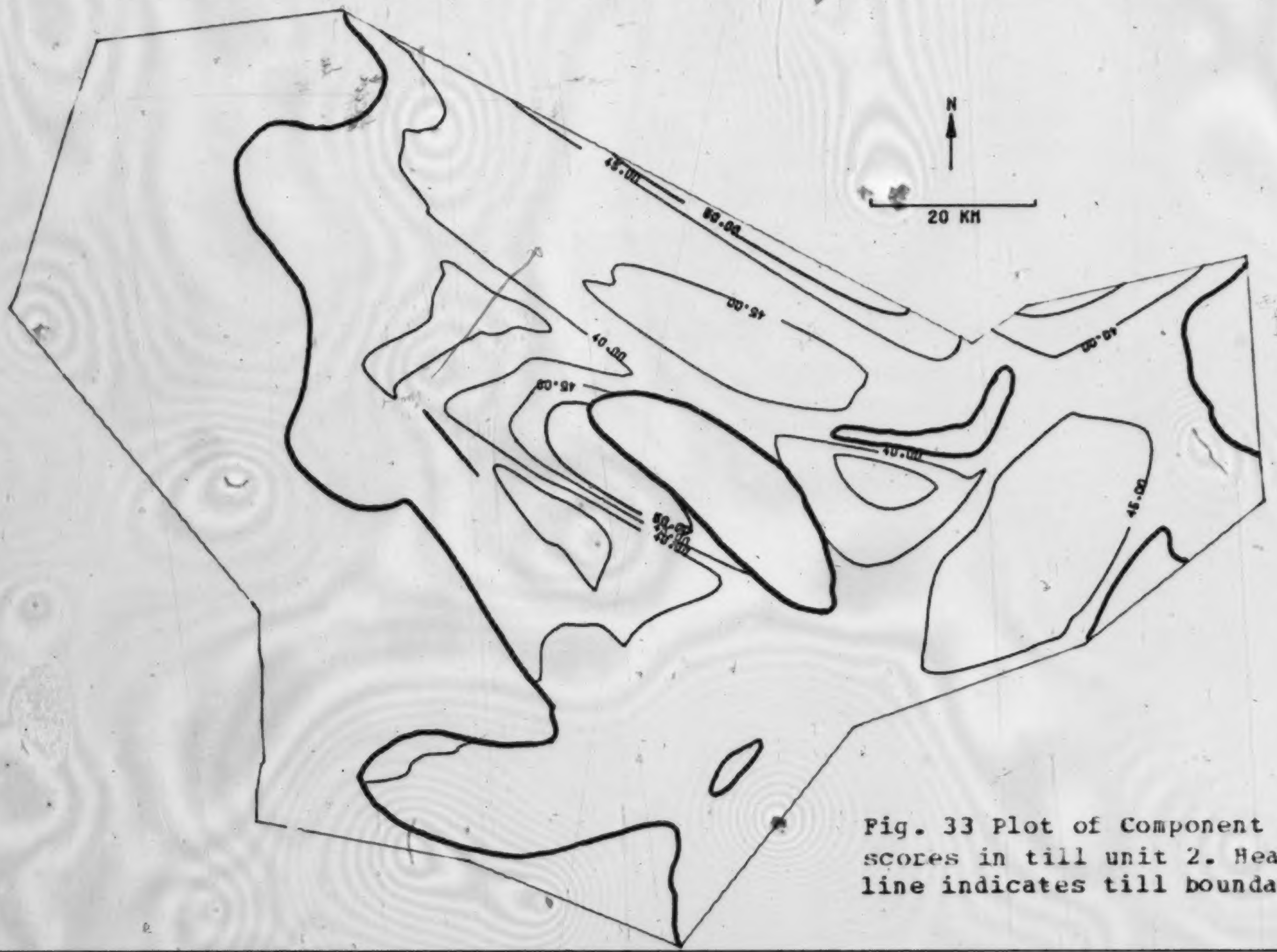

N
20 KM
45.00
50.00
45.00
40.00
45.00
50.00
45.00
40.00
40.00
45.00
40.00

Fig. 33 Plot of Component 2 scores in till unit 2. Heavy line indicates till boundary.

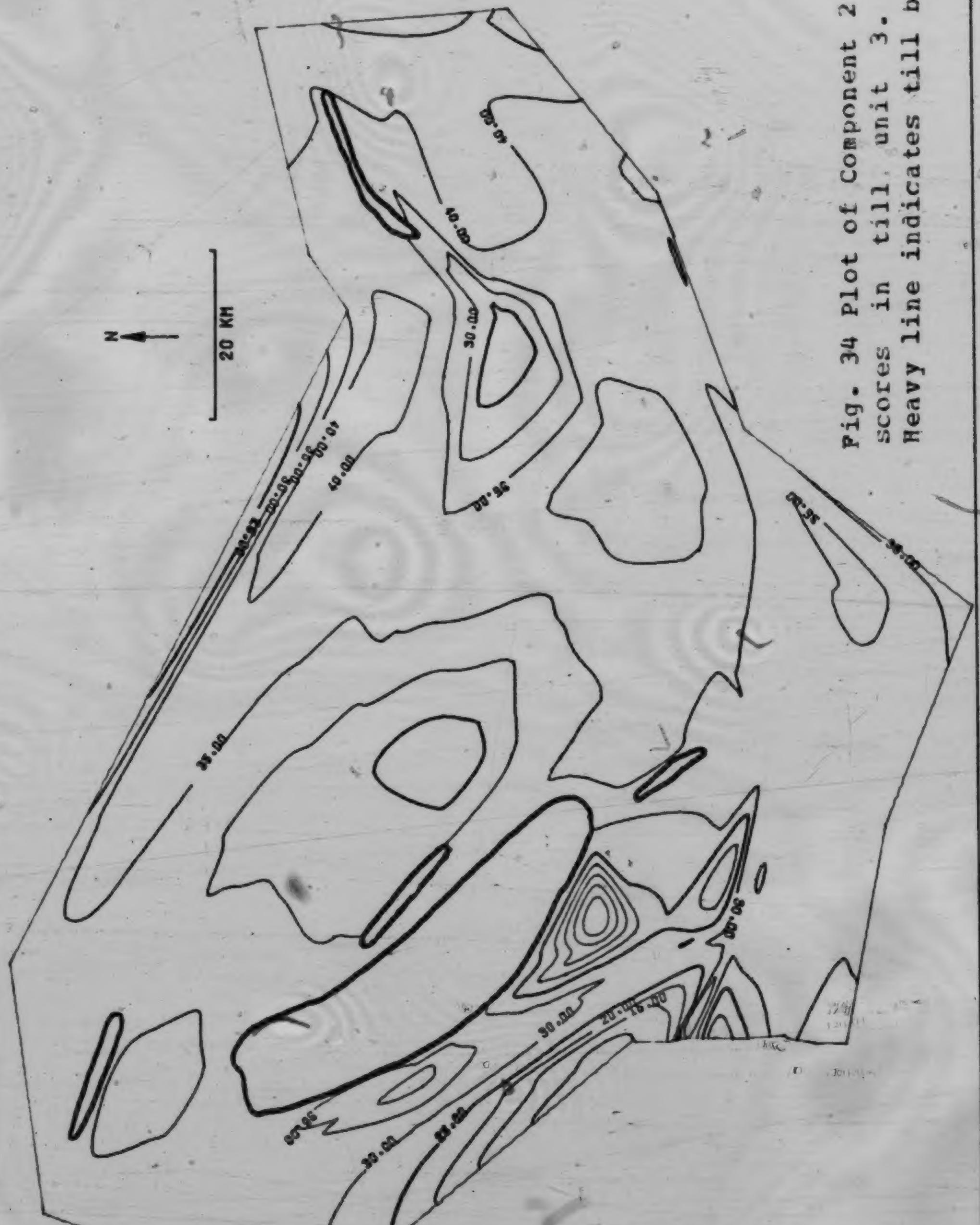

N
20 KM
40.00
35.00
30.00
20.00
10.00

Fig. 34 Plot of Component 2 scores in till unit 3. Heavy line indicates till boundary.

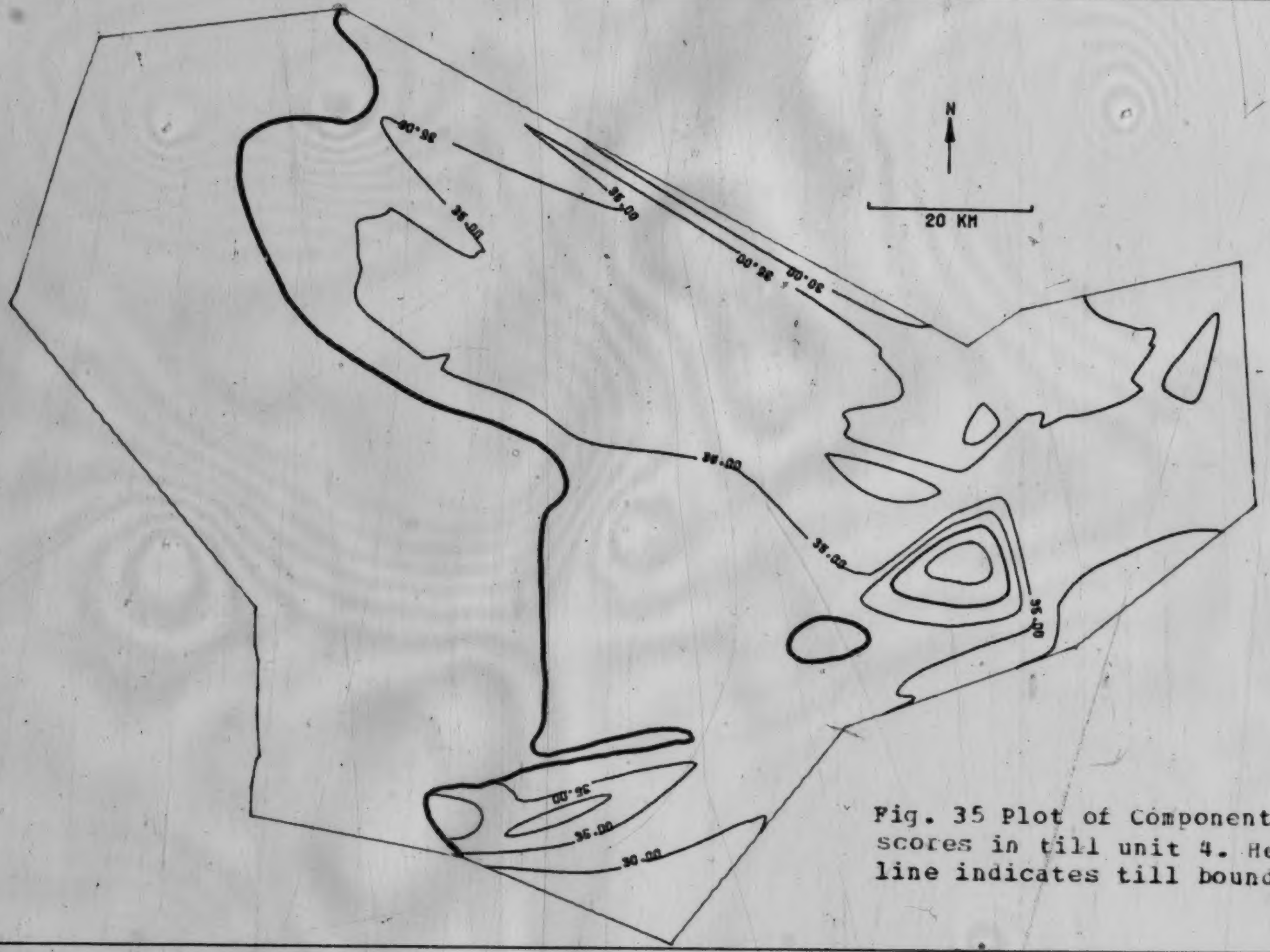

N
20 KM
35.00
30.00

Fig. 35 Plot of Component 2 scores in till unit 4. Heavy line indicates till boundary.

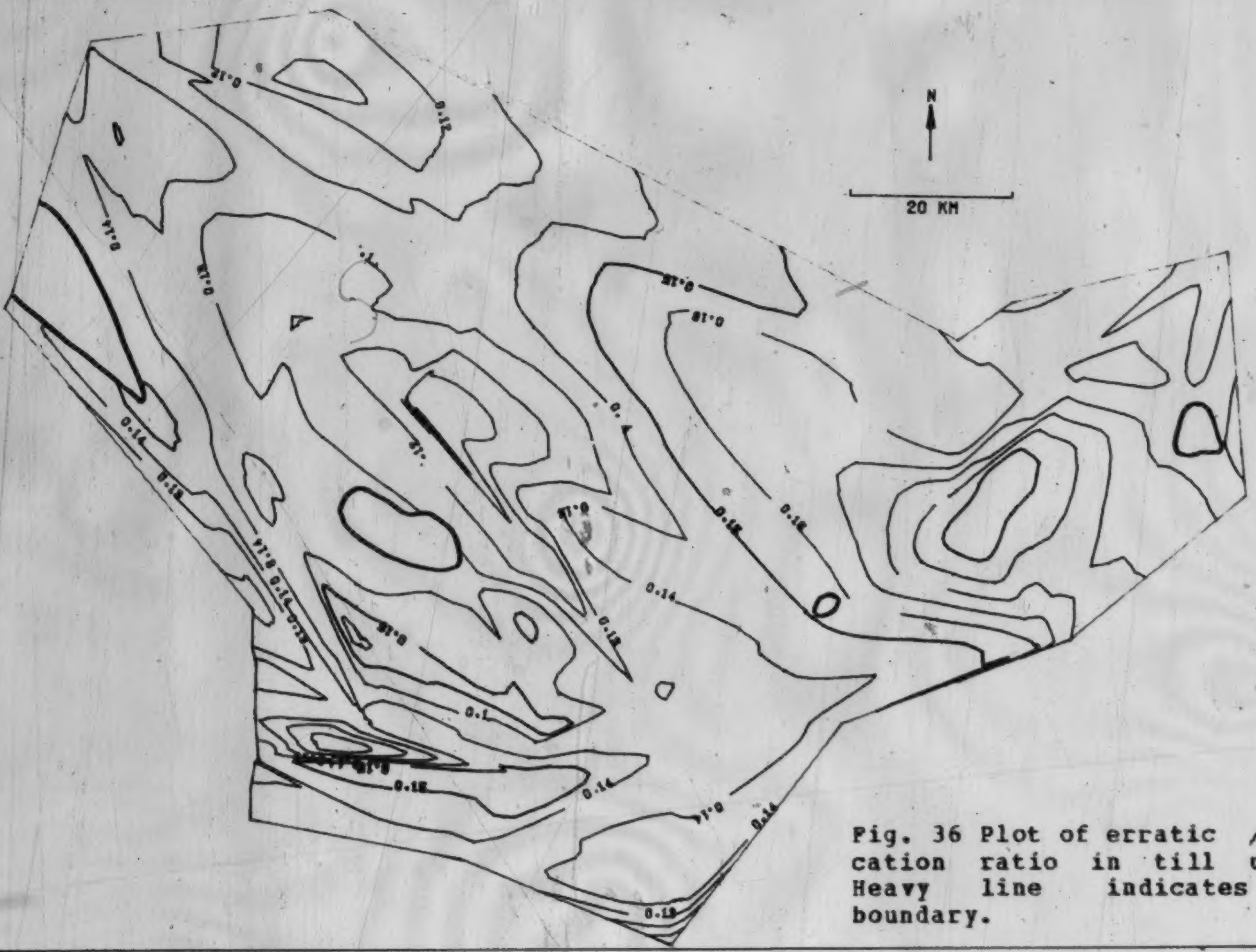

N
20 KM
0.12
0.12
0.14
0.18
0.1
0.12
0.12
0.14
0.14
0.14
0.12
0.12
0.14
0.1
0.12
0.14
0.14
0.12

Fig. 36 Plot of erratic / local cation ratio in till unit 1. Heavy line indicates till boundary.

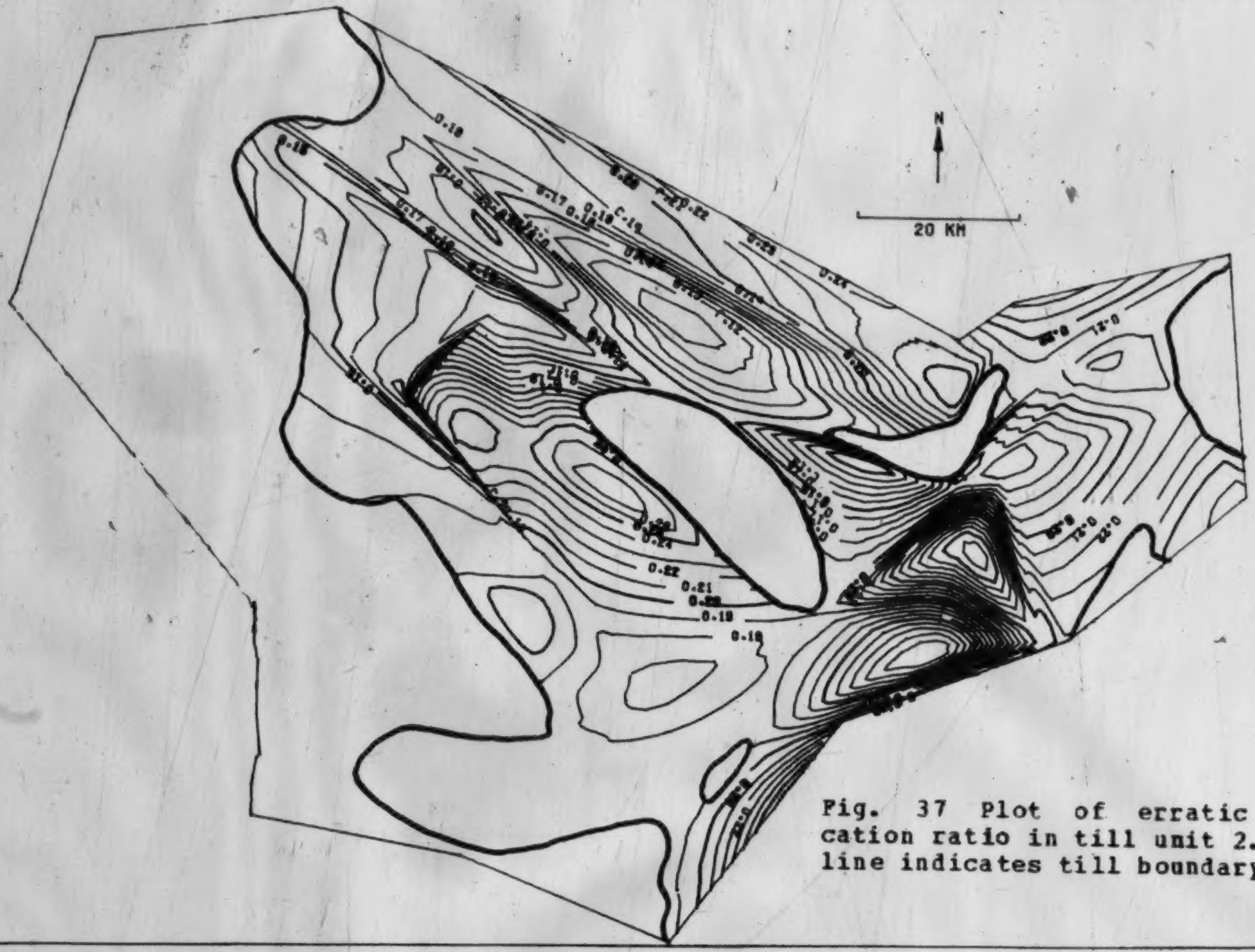

N
20 KM
0.18
0.19
0.17
0.22
0.23
0.24
0.21

Fig. 37 Plot of erratic / local cation ratio in till unit 2. Heavy line indicates till boundary.

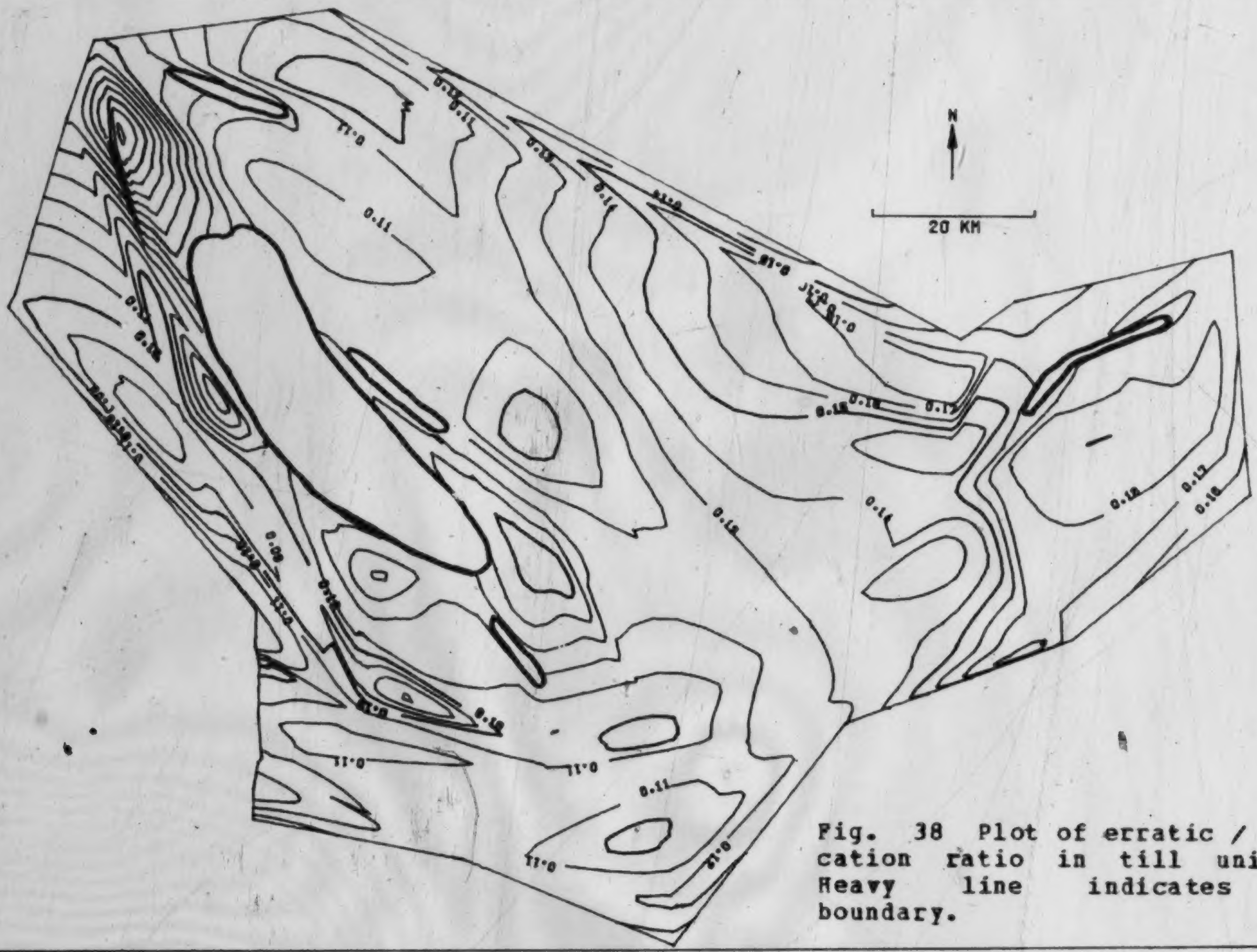

N
20 KM
0.11
0.12
0.14

Fig. 38 Plot of erratic / local cation ratio in till unit 3. Heavy line indicates till boundary.

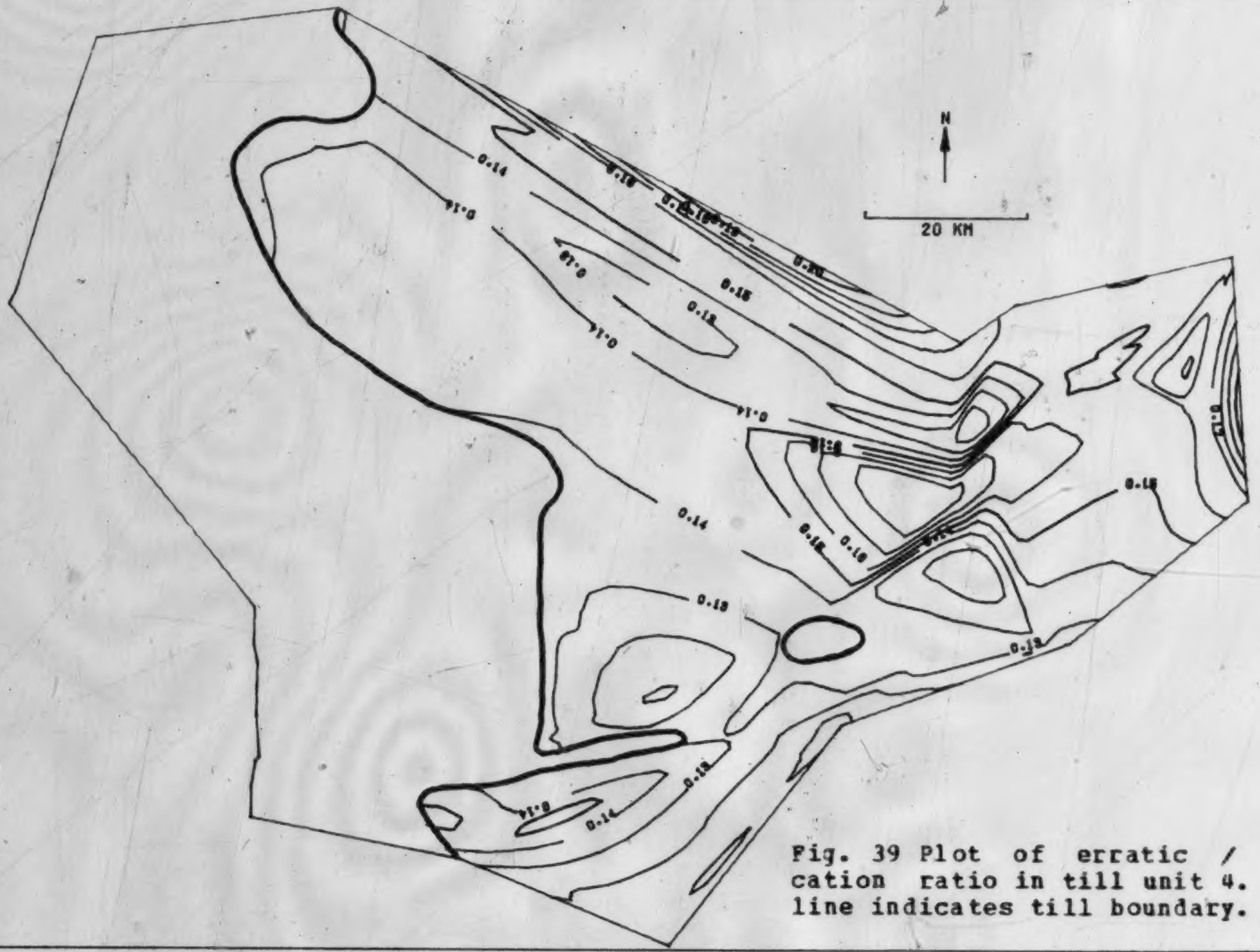

N
20 KM
0.14
0.14
0.14
0.14
0.16
0.18
0.20
0.15
0.12
0.10
0.13
0.12
0.14
0.14

Fig. 39 Plot of erratic / local cation ratio in till unit 4. Heavy line indicates till boundary.

variation in carbonate content as a function of grain size and distance of transportation from the source. They found that with increased distance the original relatively coarse material was subject to more crushing, so that the maximum concentration of erratic material was found in successively finer size fractions until a stable "terminal grade" was reached. Thus conclusions based on one size-fraction do not readily relate to those based on a different fraction. Since both calcium carbonate equivalent and bulk chemistry are measured on the silt plus clay fraction in this study the regional variation is clearly due to dilution by local material in the down-ice direction rather than by further grinding action. This holds true for all till sheets.

7.10 Local Compositional Variation

Due to poor sample distribution available for the analysis of variance of Appendix 9 it was not possible to compare the middle till, with its distinctive high erratic components against the other units. The two more extensive tills that were compared were fairly similar in their composition, since only the 40 to 60 mesh sand and the clay content differed significantly at the 5% level between all units over the map area. The sand figure is difficult to interpret, but the clay figure reinforces the visual observation that clay values often changed appreciably between units. Significant variation between the top and bottom samples of a till was only found for Na at the 5%

level, and for 20 to 40 mesh sand, silt and Mg at the 10% level. Considering the small number of samples and the low number of significantly varying analyses, it seems unlikely that a clear general change in composition of a till can be expected with depth. This agrees with visual impressions from the drill hole plots in Appendix 4 and the analysis of Appendix 8.

Various interaction effects were also found significant. The significant interaction of unit and sample position for 40 to 60 mesh sand, and carbonate grains, suggests that some units may be stratified with respect to these properties, but the lack of corroborative evidence makes this inconclusive, although the interaction between area, unit and depth found significant for sand and clay measurements suggests some textural stratification in some units in some areas. The interaction of area and unit is of interest, since it was found significant for all size analyses except 140 to 230 mesh sand, and clay. This strongly suggests that some areas of some units were markedly different in overall grain size from others, and that this effect, although affecting each till unit independently, was extensive enough to apply to a set of drill holes rather than just one. Examination of individual values shows that the upper till tends to be particularly coarse in the westernmost of the three areas examined, and the upper member of the lower till coarser in the easternmost area. Thus the texture of individual tills may be fairly homogeneous not merely throughout their depth, but laterally for several miles. This interaction suggests that local depositional conditions responsible for depositing those till units that are compositionally fairly homogeneous may have an extent roughly comparable to the areas chosen for the analysis of variance design (10-20 km). Examination of the grain size maps in Appendix 7, as well as the analysis of variance results, suggests that these medium-scale variations in composition may be associated with the topographic features encountered by the moving glacial ice.

Gillberg (1965, 1967a,b) did extensive work on the relationship of the erratic component of till to the underlying topography. He clearly showed an exponential decrease of erratic material with increasing distance from the source material, primarily due to dilution with local material. He also demonstrated the appreciable variation in local ice direction in the lower part of an ice sheet (and hence in local till composition) in response to sub-ice topography, even though the upper, major portion of the ice sheet moved in the regional direction. He concluded that if the topographic slope was such as to impede the ice flow the erratic material would be deposited rapidly, whereas with a down-ice slope, erratic material would be transported greater distances. This corresponded to up-ice dips producing zones of deposition of both the local and the erratic material being transported, and down-ice dips producing zones of erosion of local material. In the lower member of the lower till in the study area for this work the erratic component tends to be lower in the Helina and Beverly Channels and higher on the St. Lina slope, suggesting that, according to Gillberg, the former would be zones of easy flow and the latter a zone of resistance. The Kikino channel did not exist at that time. In the upper member of the lower till the erratics tend to be low in parts of the Beverly and Kikino Channels, suggesting fairly free ice flow in these, but much of the Helina channel shows little influence on the till composition, as much of it had previously been filled in.

The middle till varies widely in its erratic content and displays little pattern, and the upper till, although decreasing fairly systematically in erratic content towards the southwest, tends to have low values on the high ground and higher values in the residual low areas. No obvious explanation is available for this, although the erratic behaviour of the middle till may be due to its termination in the map area and consequently varying modes of deposition could well have been in effect at various times and places.

Thus, although medium-scale lateral variation in till composition may well reflect local depositional conditions controlled by the effect of the underlying topography on the continental ice sheet, more detailed sampling would be necessary to confirm this.

8.0 PREGLACIAL GEOLOGICAL HISTORY

8.1 Cretaceous Stratigraphy

Two Upper Cretaceous bedrock formations directly underlie the surficial deposits in the map area (Carrigy, 1972). These are the Lea Park and Belly River Formations (Fig. 40). They dip gently to the southwest, with the younger Belly River only present in the southwest quarter of the map area. The Lea Park Formation consists of massive, marine, silty, dark grey shale and argillaceous siltstone with some fine-grained sandstone lenses. The Belly River Formation consists of non-marine, fine- to medium- grained, grey argillaceous bentonitic sandstone, grey clayey siltstone and grey or carbonaceous shale (Yoon and Vander Pluym, 1974).

8.2 Tertiary Stratigraphy

Westgate (1968) cited McConnell (1886) as recognizing the presence of elevated, commonly gravel-capped plateaux in the Plains of Western Canada The implication was that the plateau surfaces once formed the level at which rivers flowed, and uplift and subsequent degradation lowered the surrounding country some 600 m. Because drainage was to the east, material clearly of Cordilleran origin was deposited throughout the plains. These formed the Saskatchewan Sands and Gravels which are well described by Stalker (1968). Although their lithology indicates this origin, rock and

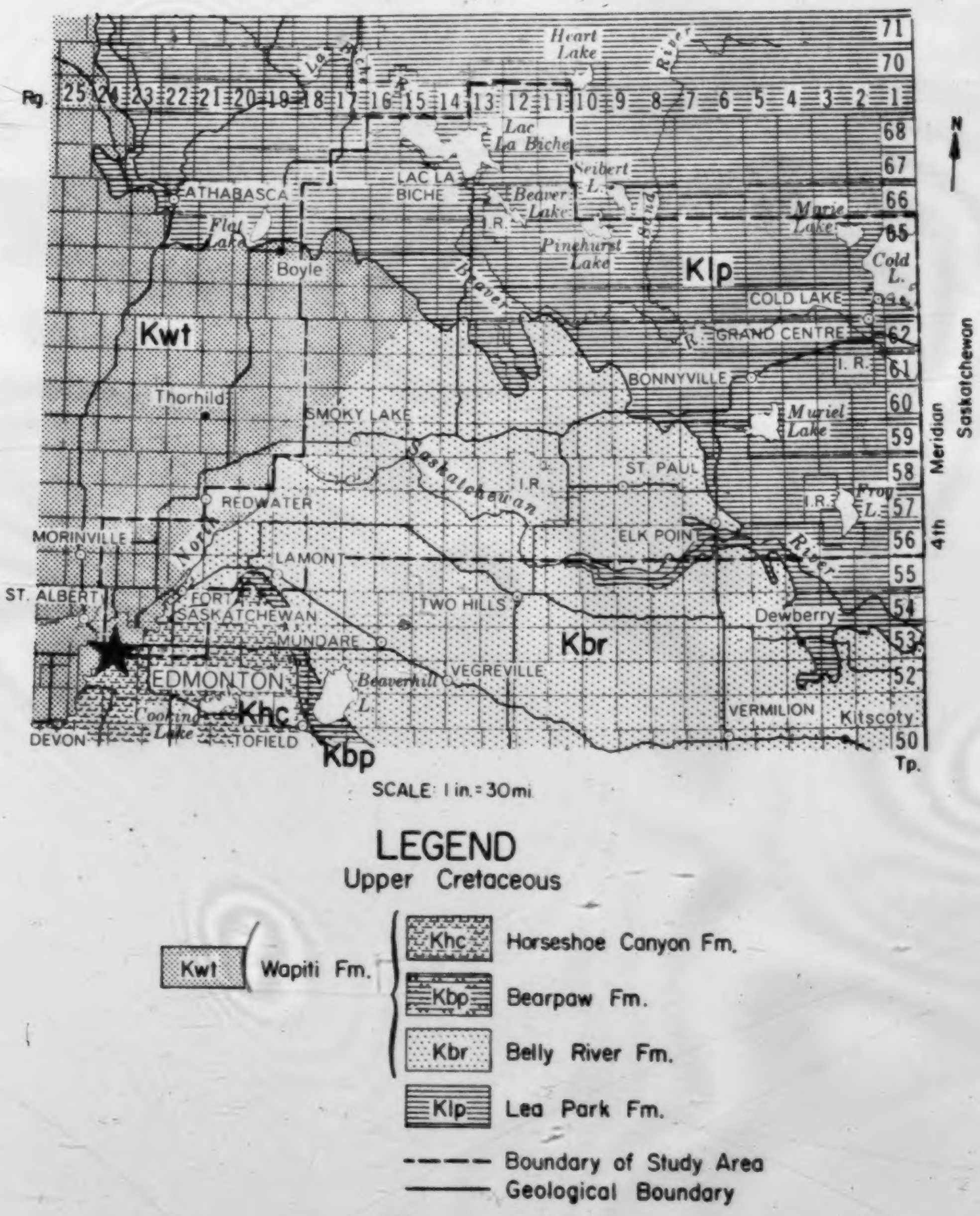

Rg.
25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
71 70 68 67 66 65 62 61 60 59 58 57 56 55 54 53 52 50
Tp.
N
4th Meridian
Saskatchewan
Heart Lake
River
La Biche R.
Lac La Biche
LAC LA BICHE
Seibert L.
Beaver Lake
I.R.
Pinehurst Lake
Marie Lake
Cold L.
COLD LAKE
GRAND CENTRE
R.
I. R.
BONNYVILLE
Muriel Lake
ATHABASCA
Flat Lake
Boyle
Beaver
Klp
Kwt
Thorhild
SMOKY LAKE
North Saskatchewan
ST. PAUL
I.R.
Frog L.
REDWATER
ELK POINT
River
MORINVILLE
LAMONT
ST. ALBERT
FORT SASKATCHEWAN
TWO HILLS
Dewberry
MUNDARE
Kbr
EDMONTON
Beaverhill L.
VEGREVILLE
Cooking Lake
Khc
TOFIELD
Kbp
VERMILION
Kitscoty
DEVON
SCALE: 1 in. = 30 mi
LEGEND
Upper Cretaceous
Kwt Wapiti Fm.
Khc Horseshoe Canyon Fm.
Kbp Bearpaw Fm.
Kbr Belly River Fm.
Klp Lea Park Fm.
Boundary of Study Area
Geological Boundary

Fig. 40 (From Yoon and Vander Pluym, 1974) Bedrock geology of the Edmonton - Lac La Biche - Cold Lake area.

mineral species resistant to weathering and erosion predominate. The immediate local sources of these gravels in the Edmonton area were the late Tertiary conglomerates that covered former extensive preglacial uplands (Rutherford, 1937). Much of this material was deposited in the preglacial valleys as the uplands were denuded. Stalker (1968) provided criteria for their recognition, including the requirement that they lie between the bedrock and the first glacial deposits. These gravels in the buried valleys form a major groundwater source in the map area.

8.3 Bedrock Channels and Preglacial Drainage

Three major buried channels have been located in the test area by previous workers - the Beverly, Helina and Kikino Channels. (Yoon and Vander Pluym, 1974). The Helina Channel is extremely broad, with low slopes to the valley walls, its shape suggesting a mature major river valley. The Beverly Channel is less broad and has steeper bedrock walls (see Fig. 25). Preglacial material has been identified in the laboratory from the Helina Channel (drill hole 833E) and the Beverly Channel (706E and 831E). Field identification of preglacial gravels without laboratory confirmation occurred in holes 808E and 809E in the Helina Channel. The Kikino Channel is fairly narrow, steep-walled and cuts across the neck between the other two channels. No preglacial material has been found in the Kikino Channel, although a field identification in hole 730E was rejected in the laboratory as being contaminated with Shield material.

To the east the merged Helina and Beverly Channels pass through Cold Lake and join a known bedrock channel that drains east (Christiansen and Whittaker, 1974). The known Vermillion Channel which enters the southeast corner of the map area also joins this river system in Saskatchewan. The smaller Vegreville Channel joins the Beverly just east of the Kikino Channel. The Beverly Channel is followed by the current North Saskatchewan upstream from the map area.

The Beverly Channel presumably contained the preglacial North Saskatchewan River (Westgate 1969, p.133). The Helina Channel probably contained the preglacial Athabasca River and possibly even the headwaters of the Peace River which may at one stage have drained east through Lesser Slave Lake, Calling Lake and Lac La Biche. (see Fig. 1 and McCrossan and Glaister, 1966) The Kikino Channel is thought to be of an early ice-marginal origin, draining water from the ice front and the North Saskatchewan northwards through Lac La Biche. The region around Lac La Biche possesses some very thick (greater than 100m) surficial deposits of gravel that is either of glacial or reworked preglacial origin. This valley deepening and gravel accumulation may be due to the Kikino ice marginal channel intersecting the preglacial Athabasca or Athabasca / Peace river system. Further drilling would have to be done to the north and west to resolve this problem. Surficial topography suggests that the preglacial Athabasca may have entered the map area from the

WNW, via Fawcett Lake and Calling Lake. The Kikino ice marginal channel may have continued NNW via Wandering River and Pelican Portage, associated with the breach in the mountain range now occupied by the Athabasca River flowing north towards Fort McMurray (see Fig. 1).

Recent work by Yoon et al. (1977) indicates the presence of an additional channel, the Primrose Channel, running just to the north of the study area between Imperial Mills (just to the north of drill hole 958E in Fig. 2) and the northern edge of Cold Lake (near hole 765E). Preglacial sands and gravels have apparently been identified in it. The preglacial Athabasca River may therefore have flowed east from near Lac La Biche to Cold Lake by either the Primrose or the Helina Channel at any given time. Further work is needed before confident descriptions may be made of the preglacial drainage in the area.

9.0 GLACIAL HISTORY

9.1 Lower Member of the Lower Till and Kikino Channel Formation

The sequence of maps of Figs. 25, 27 and 41 to 59 summarizes the glacial history of the area. Fig. 25 shows the current bedrock surface drawn by hand, utilizing not only information derived from the 78 drill-holes in Appendix 4 but data from other drill-holes and bedrock maps from other sources (Carlson 1967, Yoon and Vander Pluym, 1974). Fig. 27 is a computer drawn map of the same surface produced from the 78 drill-holes alone, as are the rest of the maps. The Helina and Beverly channels drained east through Cold Lake prior to glaciation, but the Kikino Channel in the west had not yet been cut. Fig. 41 shows the current thickness of materials deposited underneath the first glacial till whose bottom contact is shown in Fig. 42 and thickness in Fig. 43. This material includes preglacial sands and gravels in the Helina Channel as well as material deposited during the glacial advance. It can be seen from Fig. 43 that the Helina channel was partially filled with till at this time, and the Beverly channel may have been treated similarly. The ice depositing this lower member of the lower till seems to have reached most of the way up the St. Lina slope (at the junction of the Beverly and Helina Channels) and stopped. Since this would have blocked the drainage of the preglacial North Saskatchewan it was forced to cut the narrow ice-

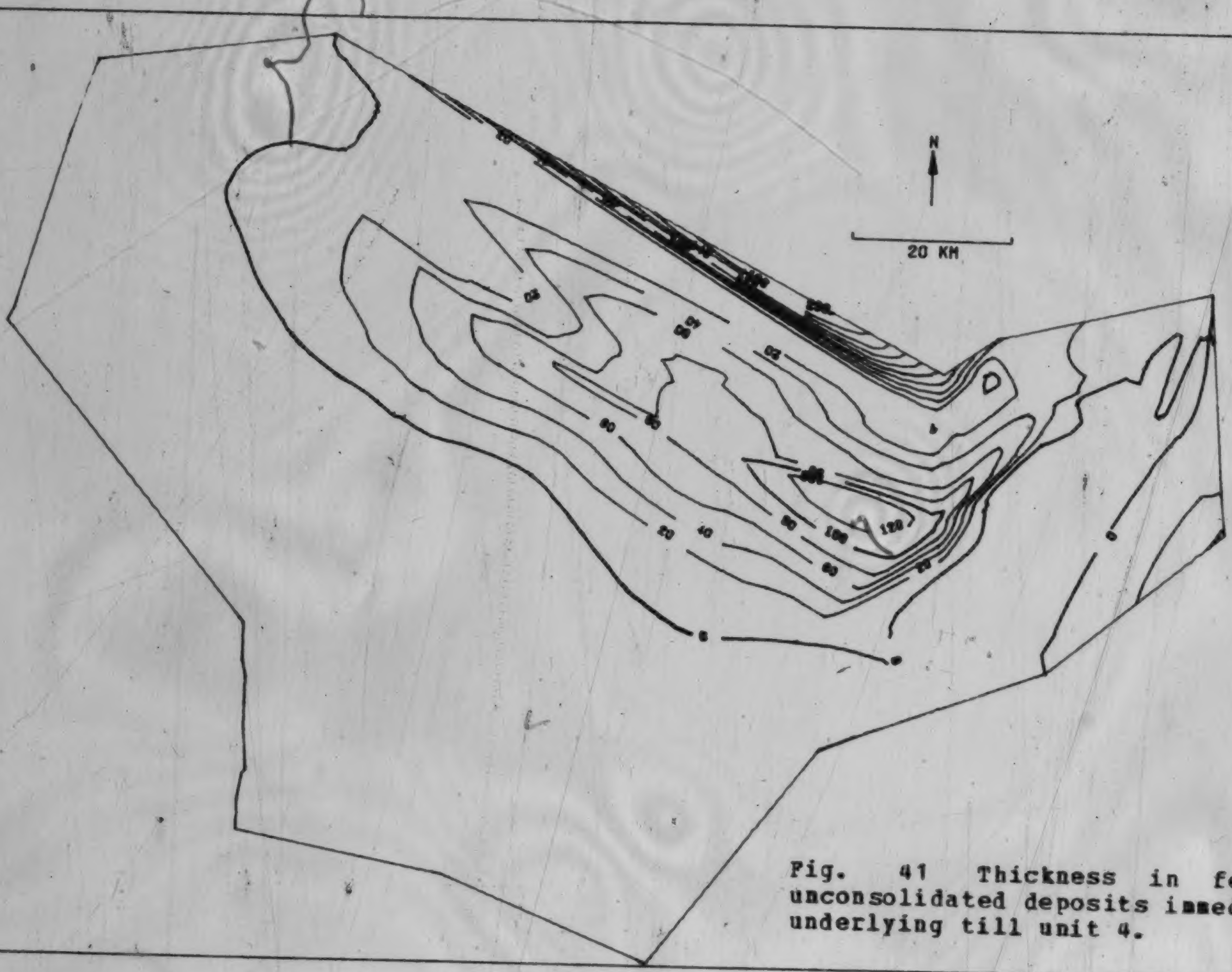

N
20 KM
0
20
40
60
80
100
120
0

Fig. 41 Thickness in feet of unconsolidated deposits immediately underlying till unit 4.

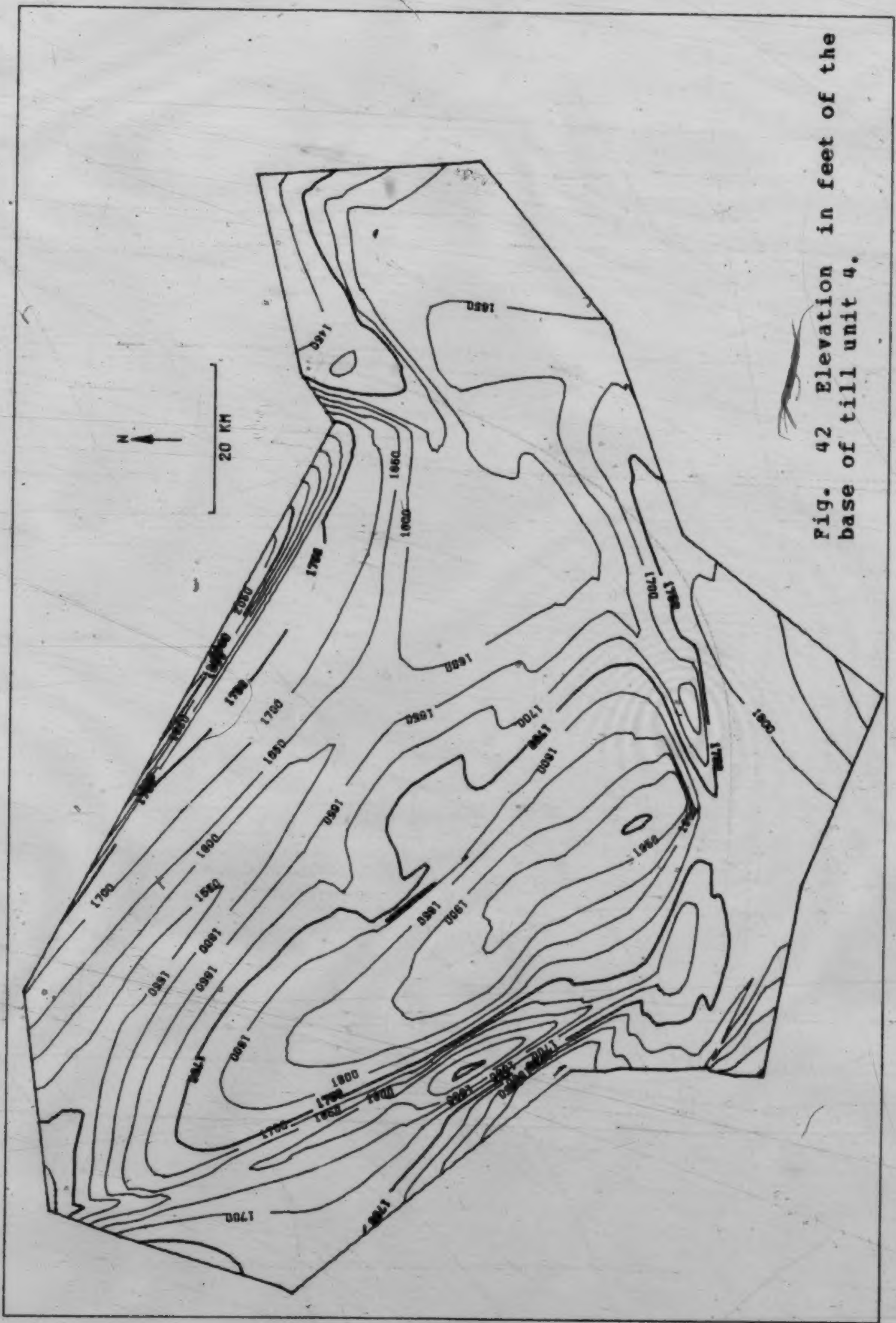

N
20 KM
1650
1700
1750
1800
1850
1900
1950
2050

Fig. 42 Elevation in feet of the base of till unit 4.

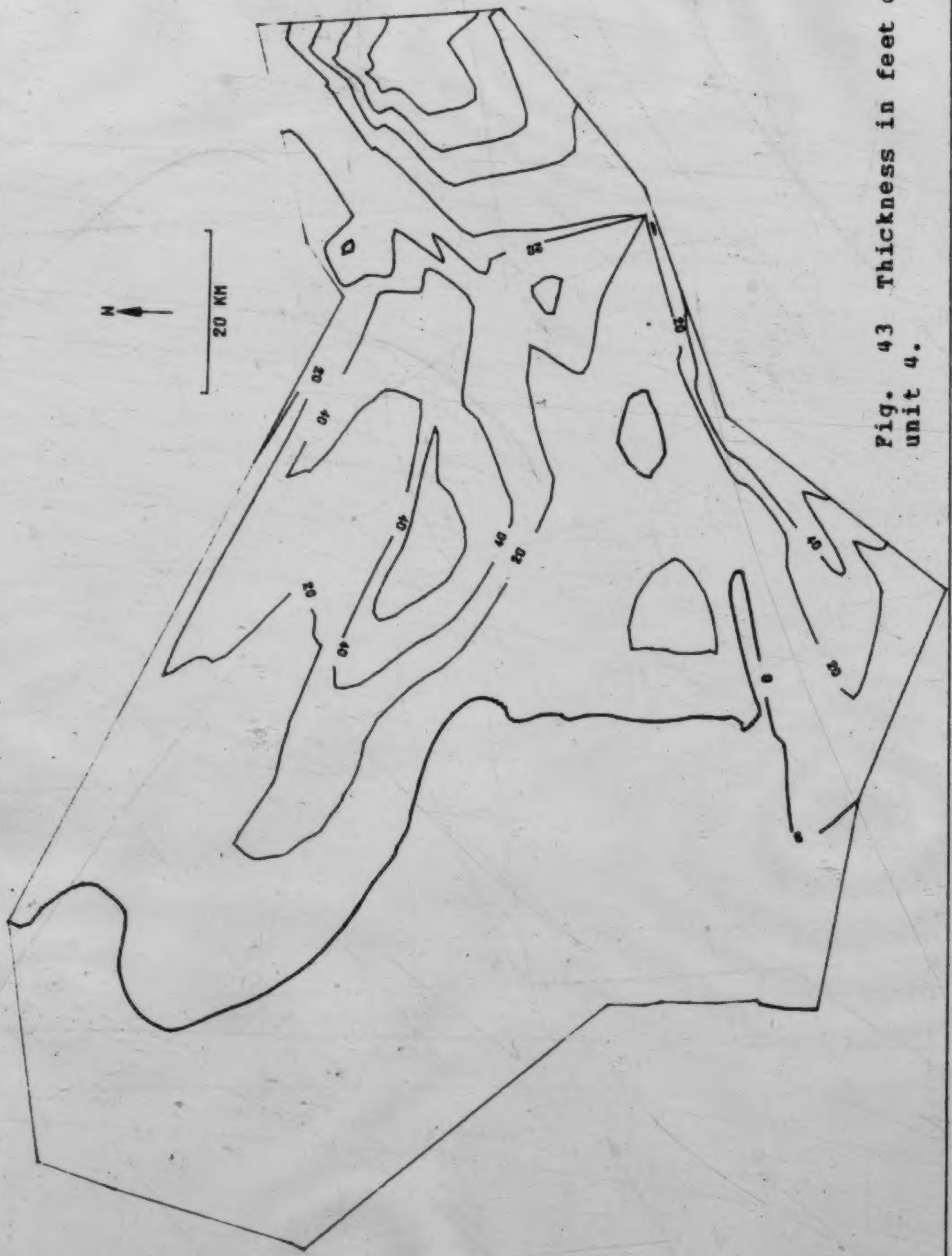

N
20 KM
20
40
40
20
40
40
20
20
20
0
40
20
0

Fig. 43 Thickness in feet of till unit 4.

marginal Kikino Channel in order to drain northwest through Lac La Biche. The preglacial Athabasca river would have been treated similarly and the water of both dammed rivers, together with the ice run-off would have been channeled northwards towards Fort McMurray as described earlier.

Although it is usually considered that ice-marginal channels are supplied predominantly by ice run-off, the Kikino channel does not appear to be present to the south of the Beverly channel. Although ice-shoved bedrock is common in the area, the bedrock topography map (Yoon and Vander Pluym 1974, Fig. 6) does not indicate even a blocked route for a southern extension of the Kikino channel, strongly suggesting that this channel is in fact due to redirected river drainage. This idea was also made by Rutherford (1941) to explain the general drainage pattern of the Saskatchewan River system, where most channels show an abrupt bend to the southeast suggesting that drainage, being blocked by ice, was forced to flow along or roughly parallel to the ice front. Ultimately the channels turn again to the northeast, indicating that the regional slope was still in that direction. In the same paper the author showed the northwestern extension of the "Altamont" moraine associated with the Coteau in Saskatchewan passing along the more recently discovered Kikino channel. Another morainal system, the "Viking", is shown passing in a north-south direction a few miles further to the west. This suggests that one, if not two, regional glacial advances stopped near the western portion of the map area.

9.2 Deposition of the Upper Member of the Lower Till

Following the deposition of the lower member of the lower till the ice probably retreated to the northeast. On the basis of the estimated topography of the top contact of the lower member of the lower till (Fig. 44), the Helina channel seems to have remained blocked. The Athabasca continued to drain north, but it is uncertain whether the North Saskatchewan resumed its old course as suggested by Fig. 44, or continued to follow the Kikino Channel as suggested by the bottom contact of the upper member (Fig. 46). Fig. 45 shows the thickness of non-till material below the upper member and above the lower member in the eastern part, where the lower member ice did not advance. It is frequently impossible to tell, in the absence of a particular till in any one drill hole, whether the non-till material was deposited before, after or contemporaneously with the missing till. Consequently Fig. 45 and other maps of this type assume the material to be as young in age as the tills present will permit. In the case of Fig. 45 the deposits between the upper and lower members of the lower till therefore include in the west some preglacial gravels as well as some presumed glacio-fluvial material deposited in front of the ice.

Fig. 47 shows the thickness of upper member of the lower till deposited. It can be seen to cover the whole map

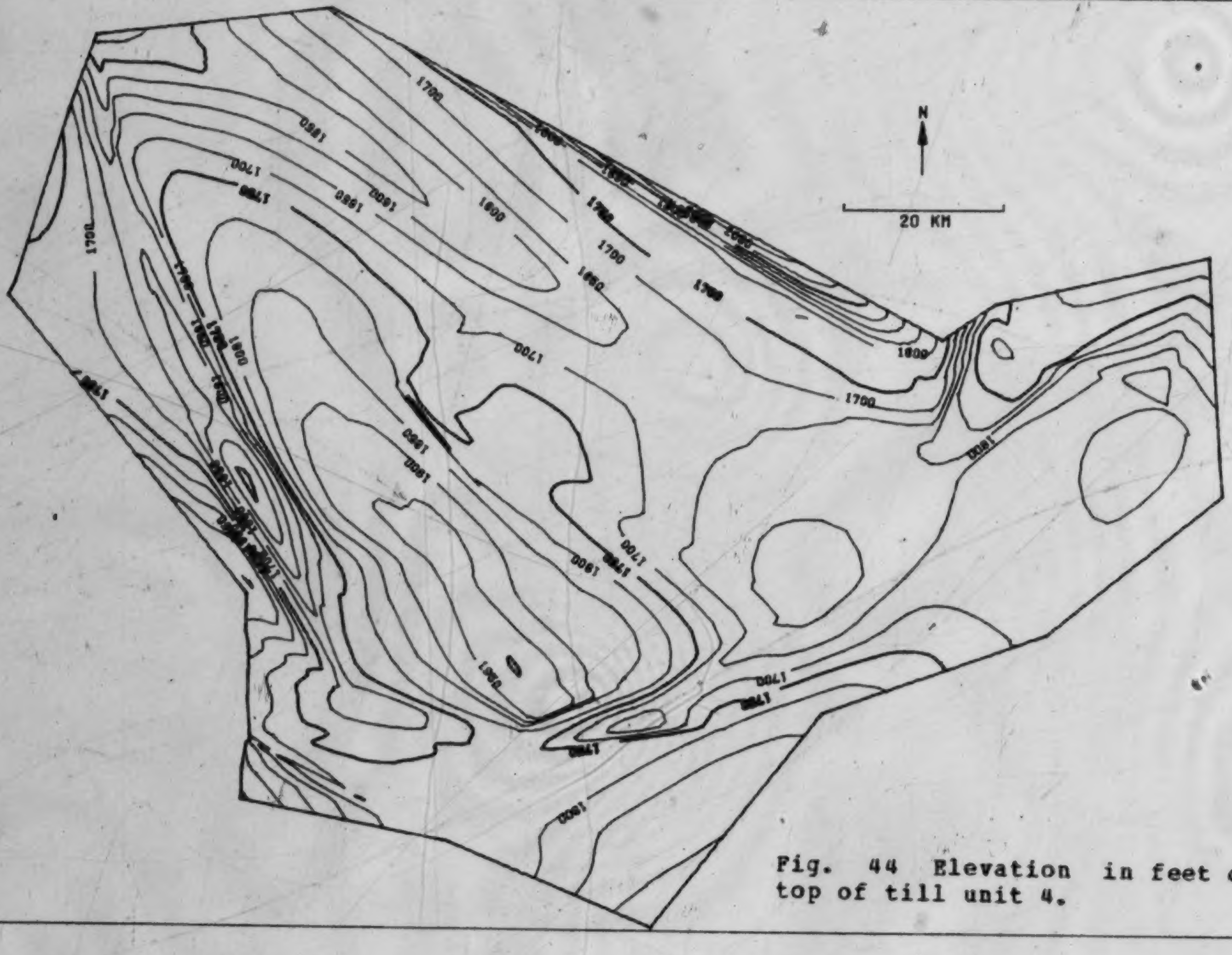

N
20 KM
1700
1800
1900
1600

Fig. 44 Elevation in feet of the top of till unit 4.

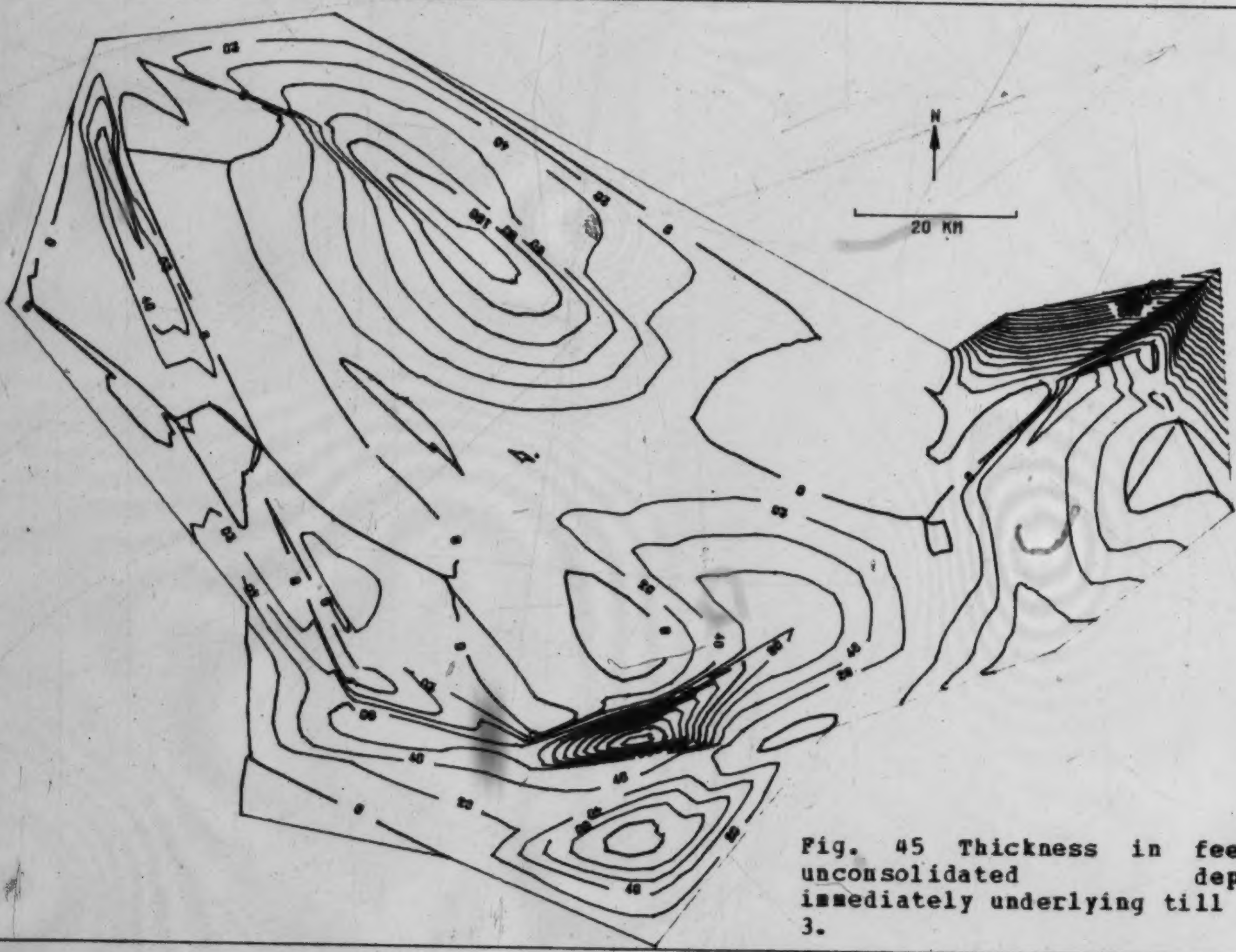


Fig. 45 Thickness in feet of unconsolidated deposits immediately underlying till unit 3.

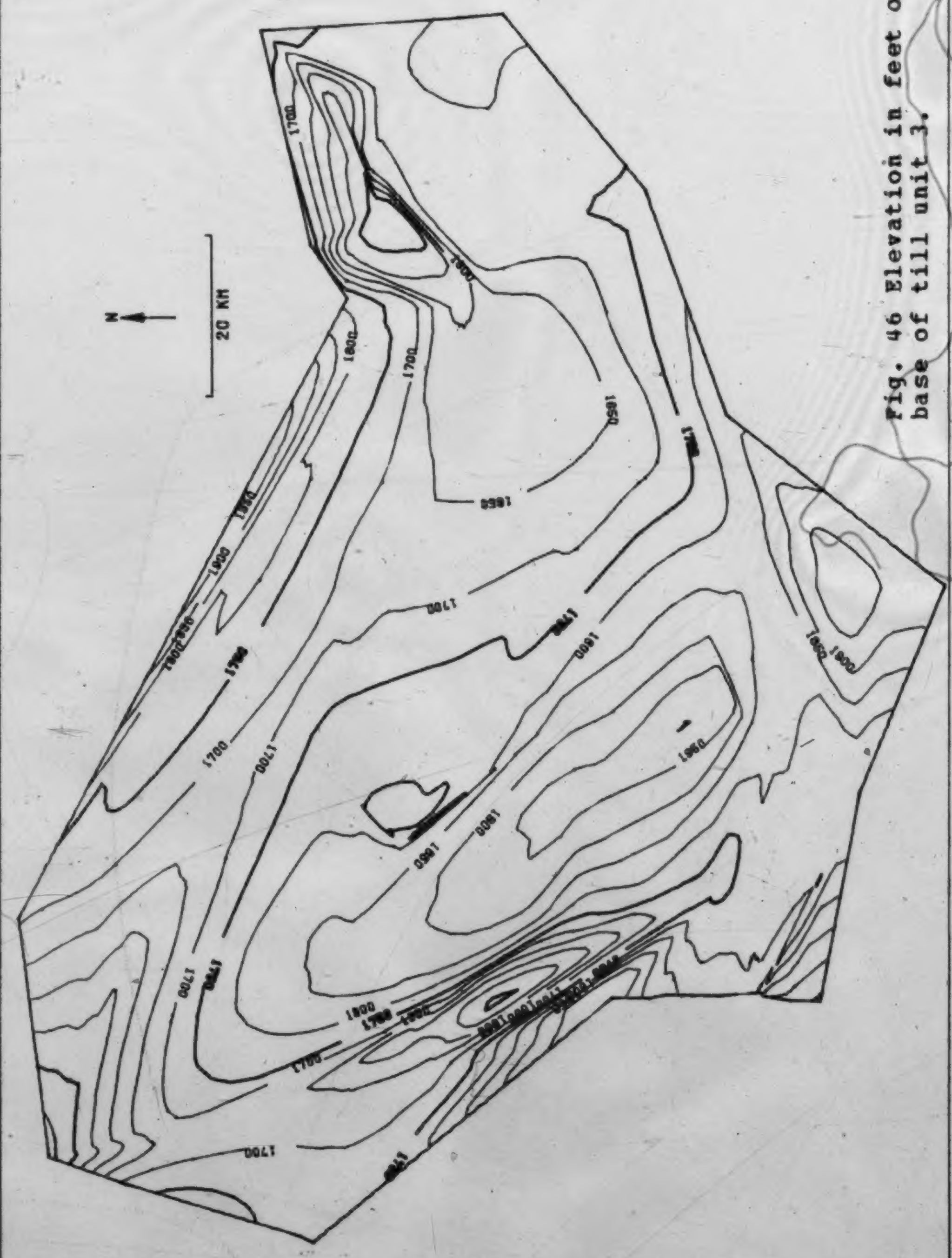

N
20 KM
1700
1800
1850
1900

Fig. 46 Elevation in feet of the base of till unit 3.

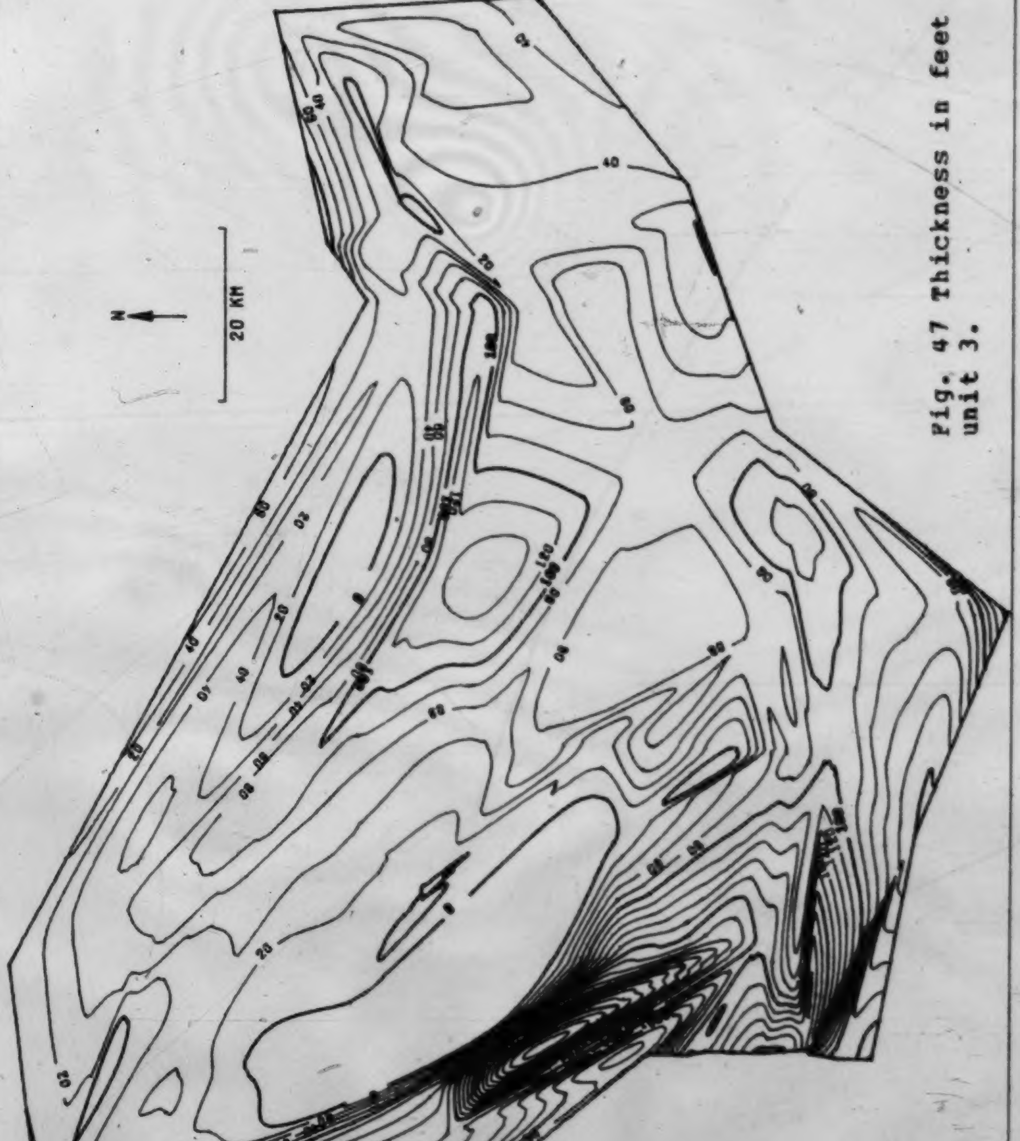


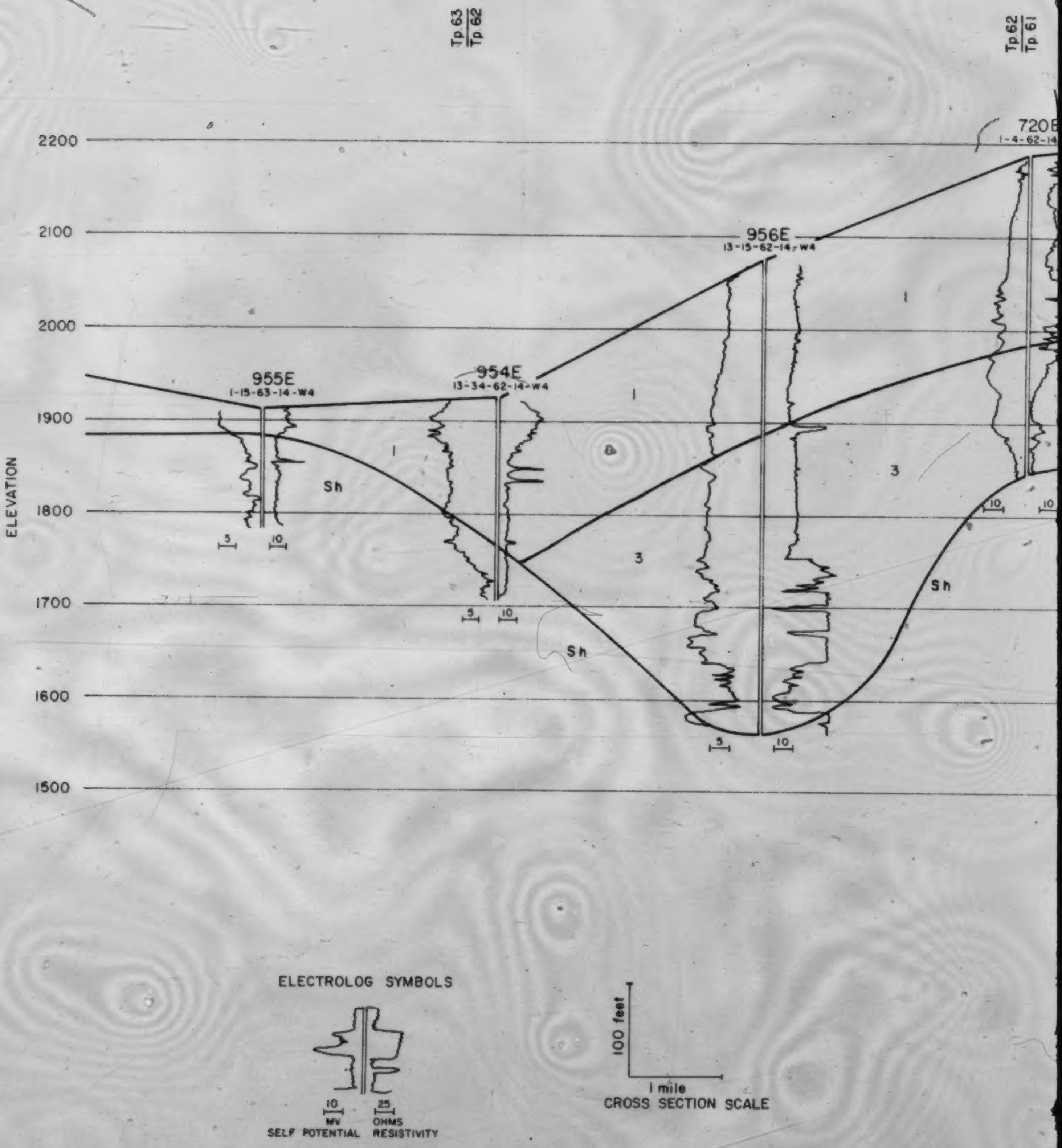
Fig. 47 Thickness in feet of till unit 3.

area with the exception of the Whitefish Lake bedrock high. Thicknesses of greater than 300 feet (100m) are found filling in the recently-formed Kikino Channel. This great till thickening suggests that the higher ground on the western boundary of the map area again formed an impediment to further ice movement. That this is the case is supported by the fact that some or much of the upper member till on the west side of the Kikino channel is composed of disturbed bedrock. This is the case for drill-holes 952E, 953E, 956E and 957E.

9.3 Bedrock Thrusts

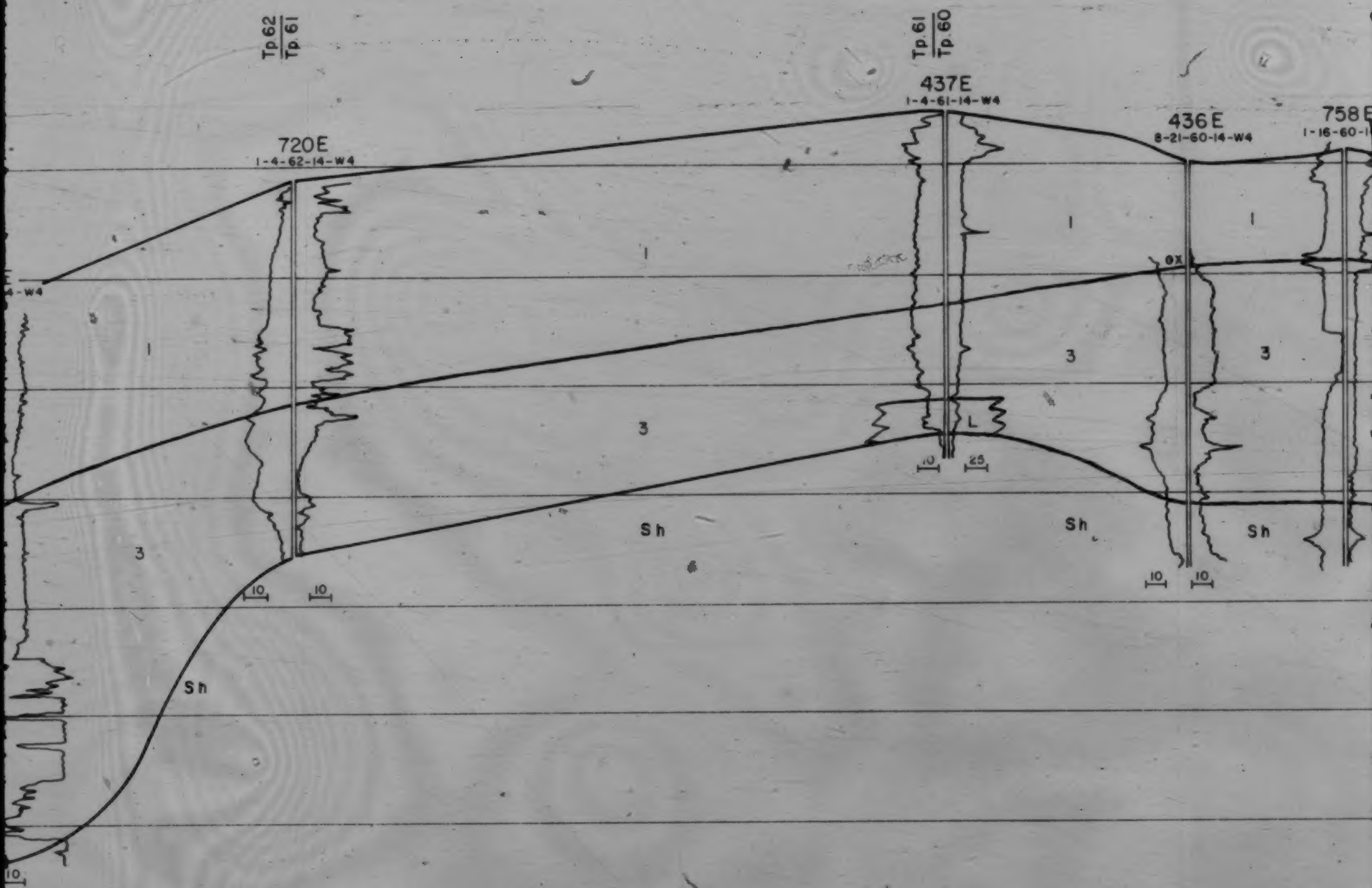
St. Onge (1972) noted the hummocky moraine associated with the high ground just to the west of the region now associated with the Kikino channel. He remarked (p. 93) "Ridges on both sides of Lake Amisk and south of Kikino are also associated with it. The ridges south of Kikino represent a large push moraine constructed by southwesterly flowing ice." While the current work suggest that the ridges were formed prior to the deposition of the uppermost till, both sets of ridges are associated with disturbed bedrock - the Lake Amisk ridges are near drill-holes 952E and 953E while the Kikino ridges are near drill-holes 956E and 957E. These morainal features may well be associated with the suggested Viking moraine of Rutherford (1941).

Of particular note are the sampled drill-holes 434E and 828E together with the other drill-holes in the cross-section of Fig. 48. On the basis of drill holes on either side of the cross-section (Yoon and Vander Pluym 1974, Fig. 6) the Beverly channel should intersect the cross-section near drill hole 434E with a valley floor below 1800ft (550m). However, the drill holes (which are numbered in chronological order) prior to number 828E had identified a bedrock plateau at 1850ft. between holes 435E and 436E, and a surprising bedrock high of approximately 2100ft. elevation where the channel was expected. The subsequent drilling of hole 828E to depths well below the first occurrence of bedrock material initially indicated that permeable material occurred below 130ft. of shale. This suggested that the missing valley floor had been found at this location, with a rather implausible bedrock high immediately to the north. Subsequent examination suggested that the bedrock high was in fact an ice-shoved bedrock slab of shale overlain by sandstone. The Lea Park Shale - Belly River Sandstone contact subcrops in this area (Fig. 40), and holes 759E and 796E to the south terminate in the sandstone while holes 735E, 754E and others to the north terminate in the shale. For this reason the first sandstone / shale sequence in holes 828E and 434E is interpreted as an upward-thrust ice-shoved bedrock slab. The second sandstone is interpreted as Belly River Sandstone in place, underlain by Lea Park Shale. Hole 795E also terminates in the Belly River Sandstone. It is thought that this bedrock slab was thrust across the Beverly Channel by the ice advance that deposited the upper



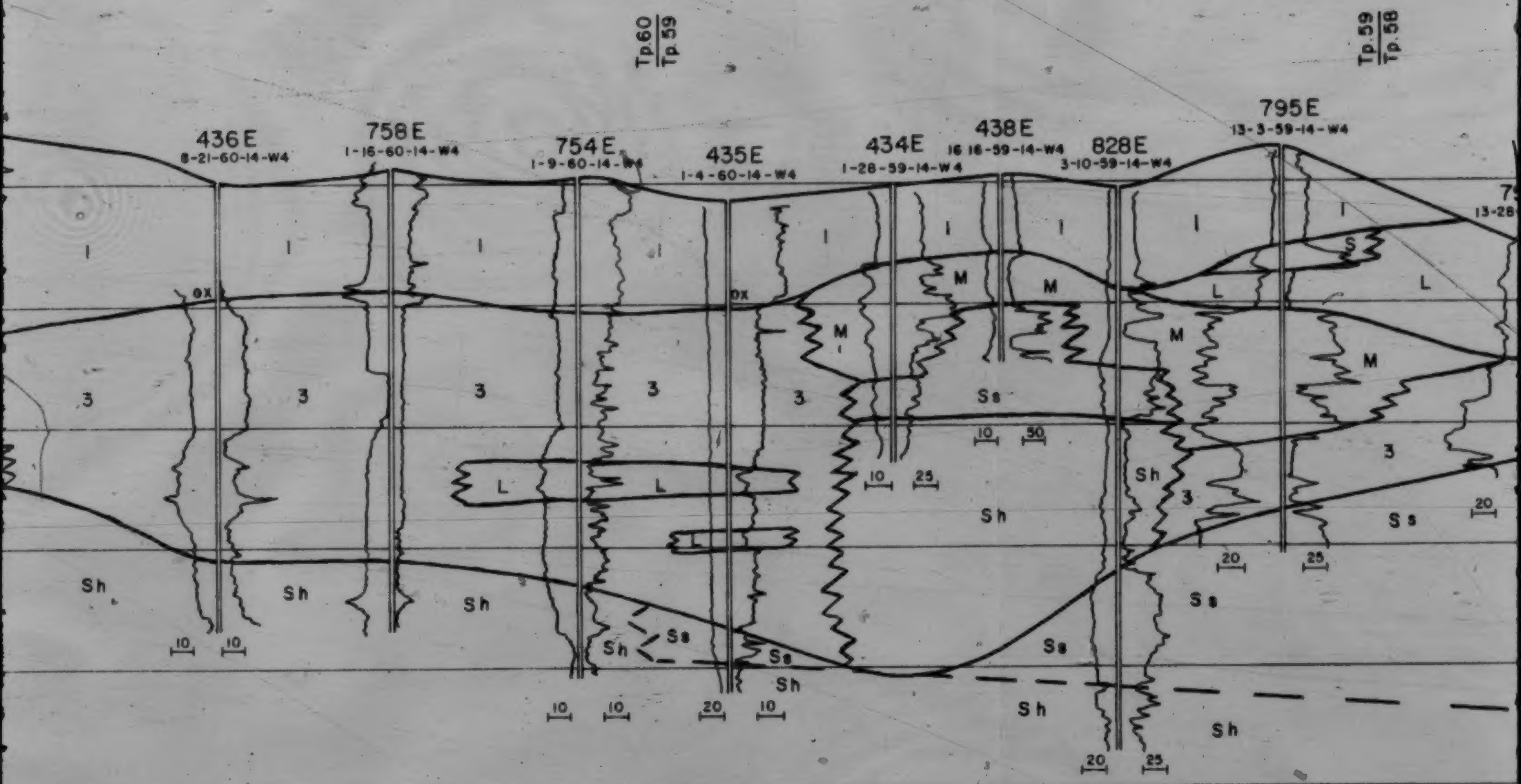
Tp.63
Tp.62
Tp.62
Tp.61
2200
2100
2000
1900
1800
1700
1600
1500
ELEVATION
955E
1-15-63-14-W4
954E
13-34-62-14-W4
956E
13-15-62-14-W4
720E
1-4-62-14
1
Sh
3
5
10
ELECTROLOG SYMBOLS
10
MV
SELF POTENTIAL
25
OHMS
RESISTIVITY
100 feet
1 mile
CROSS SECTION SCALE

L


Tp.62
Tp.61
Tp.61
Tp.60
720E
1-4-62-14-W4
437E
1-4-61-14-W4
436E
8-21-60-14-W4
758E
1-16-60-1
-W4
1
1
1
1
3
3
3
3
L
GX
Sh
Sh
Sh
Sh
Sh
10
10
10
25
10
10
10

LEGEND

1	Till unit 1	L
3	Till unit 3	M
S	Sand &/or gravel	Ss.
		Sh


Tp.60
Tp.59
Tp.59
Tp.58
436E
8-21-60-14-W4
758E
1-16-60-14-W4
754E
1-9-60-14-W4
435E
1-4-60-14-W4
434E
1-28-59-14-W4
438E
16-16-59-14-W4
828E
3-10-59-14-W4
795E
13-3-59-14-W4
ox
1
3
L
M
S
Ss
Sh
10
20
25
30

LEGEND

1 Till unit 1
3 Till unit 3
S Sand &/or gravel
L Lacustrine silt & clay
M Mixed sand, lacustrine, bedrock or till
Ss Bedrock sandstone
Sh Bedrock shale

Fig. 48

North - south cross-section
through the Vilna bedrock th

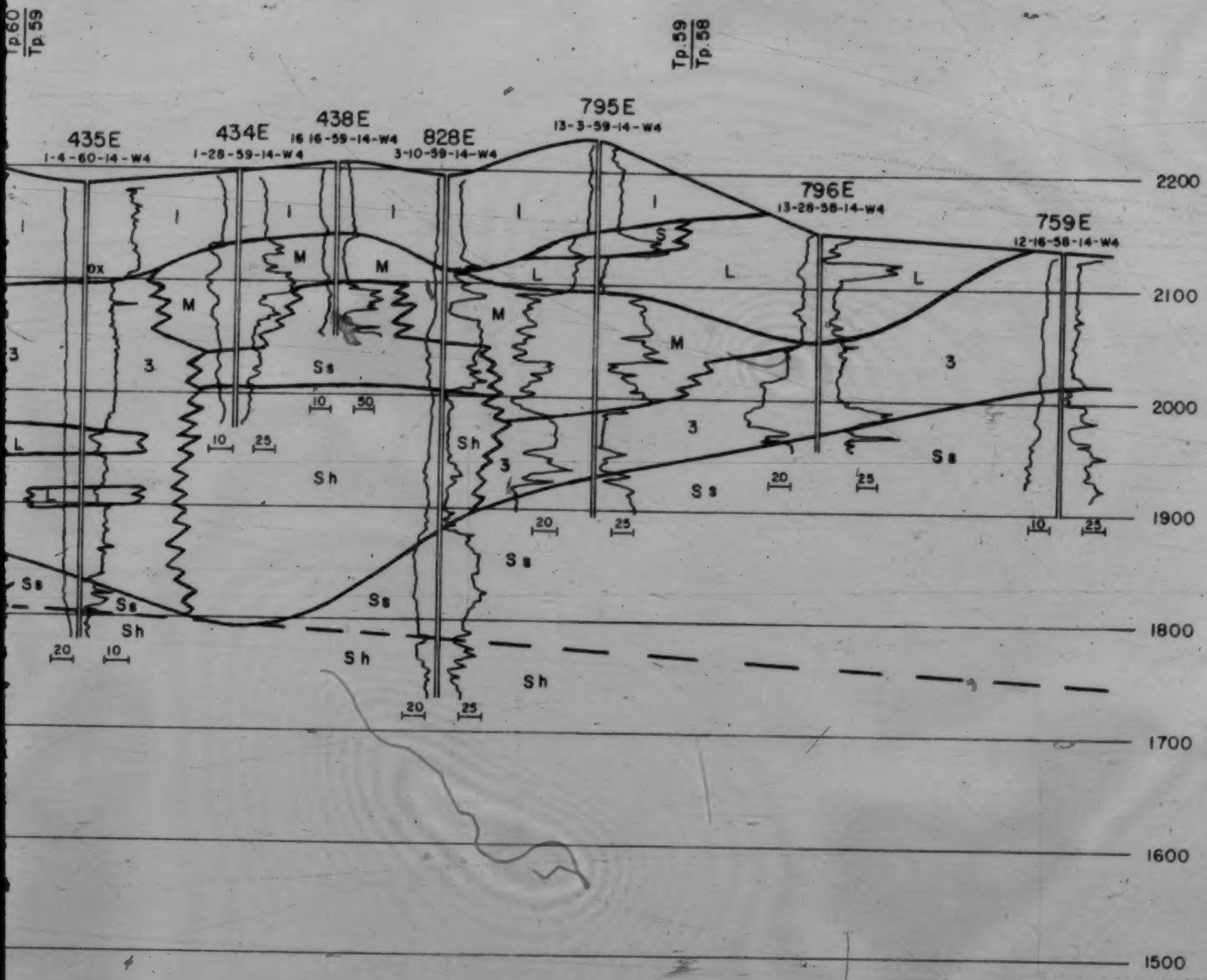

Tp.60
Tp.59
Tp.59
Tp.58
435E
1-4-60-14-W4
434E
1-28-59-14-W4
438E
16 16-59-14-W4
828E
3-10-59-14-W4
795E
13-3-59-14-W4
796E
13-28-58-14-W4
759E
12-16-58-14-W4
2200
2100
2000
1900
1800
1700
1600
1500
I
M
L
S
3
Ss
Sh
ox
10
20
25
50

Fig. 48

North - south cross - section

through the Vilna bedrock thrust.

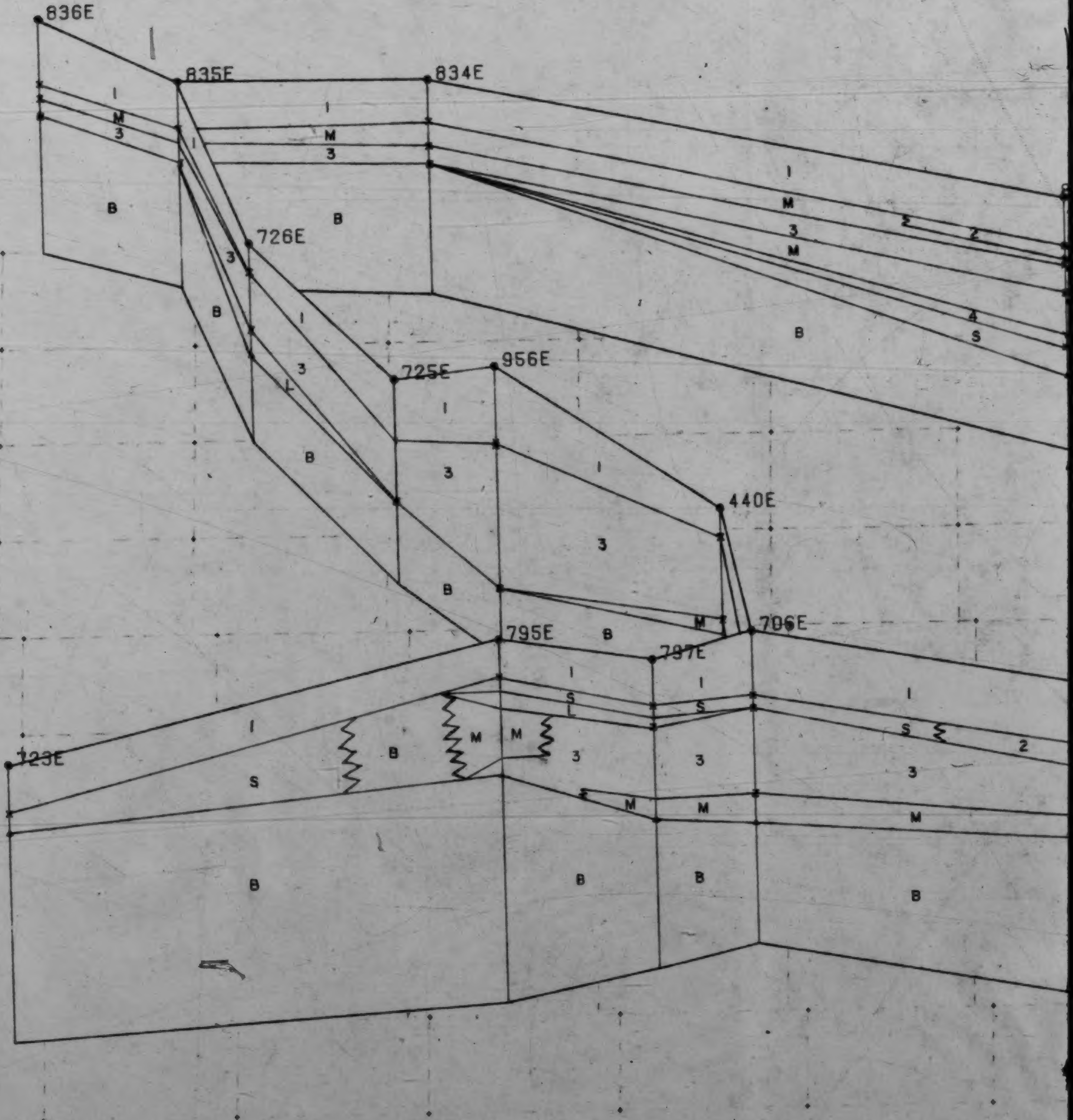
bedrock or till

494

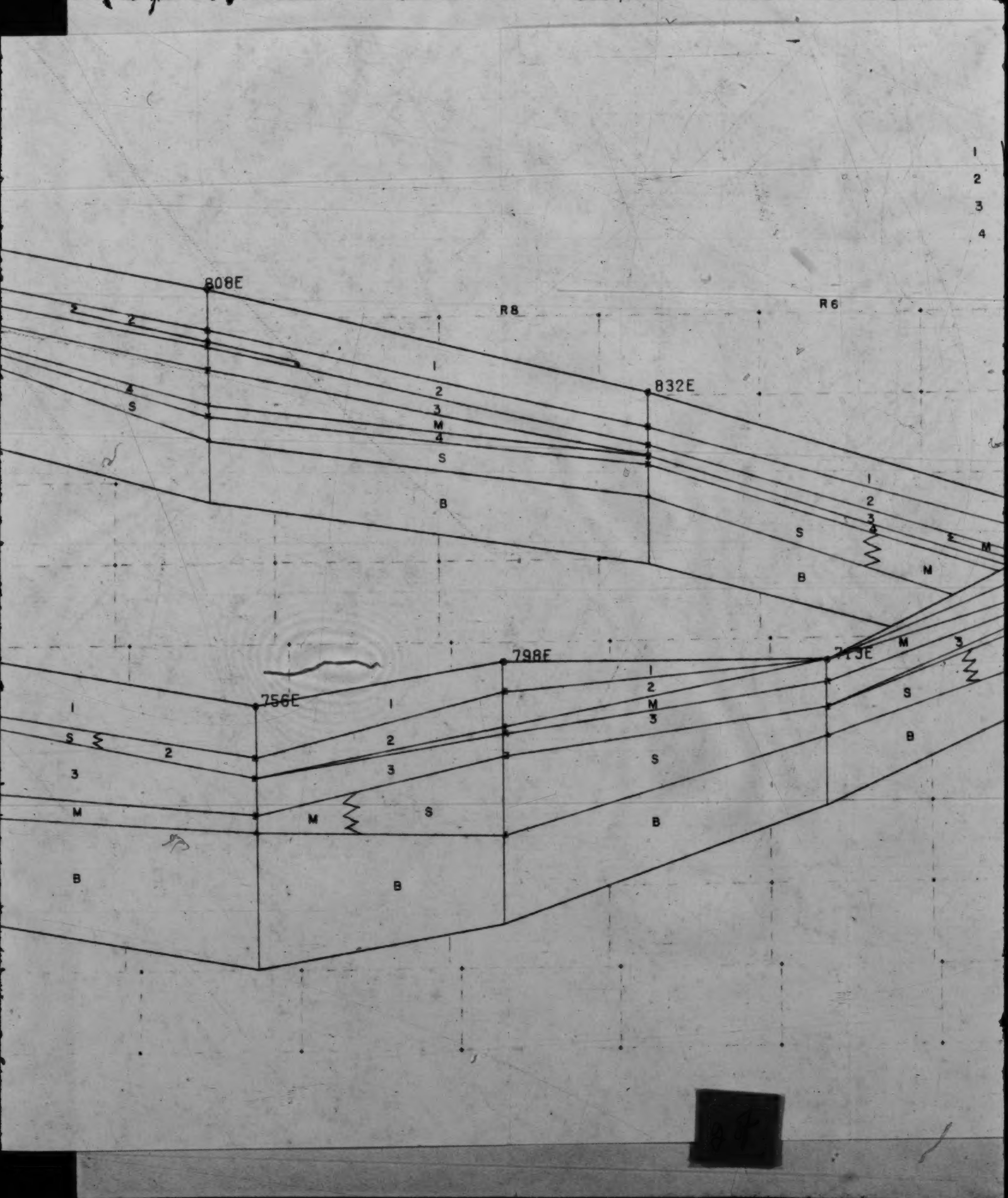
member of the lower till. This interpretation is supported by the presence of bedrock thrust ridges further north in the Kikinc Channel (St. Onge, 1972) and also by extensive disturbed bedrock found in drill holes 952E, 953E, 956E and 957E.

The high ground formed by the bedrock thrust extends nearly to Wahstac and appears to have formed a permanent dam preventing the North Saskatchewan from following the Beverly Channel any further (Figs. 25 and 49). The river, thus dammed, was forced to cut an outlet to the south, eroding over 100 feet (30m) of bedrock in the process. It is not clear to what extent the upper member of the lower till extends to the west of the Vilna-Wahstao barrier.

While the separation of the lower till into upper and lower members may be uncertain on the basis of composition alone it is quite clear that some action, prior to the dominant upper member deposition and subsequent to the initial disruption of the preglacial drainage, must have caused the Kikino Channel to be formed, and a lower member ice advance as estimated from electric logs reached approximately the right location. An alternative, if similar, interpretation is that the upper member glaciation paused for an extended period of time just to the east of the current Kikino Channel position and the ice marginal channel was formed, only to be buried immediately the ice readvanced.


I
M
B
L
S

1 of

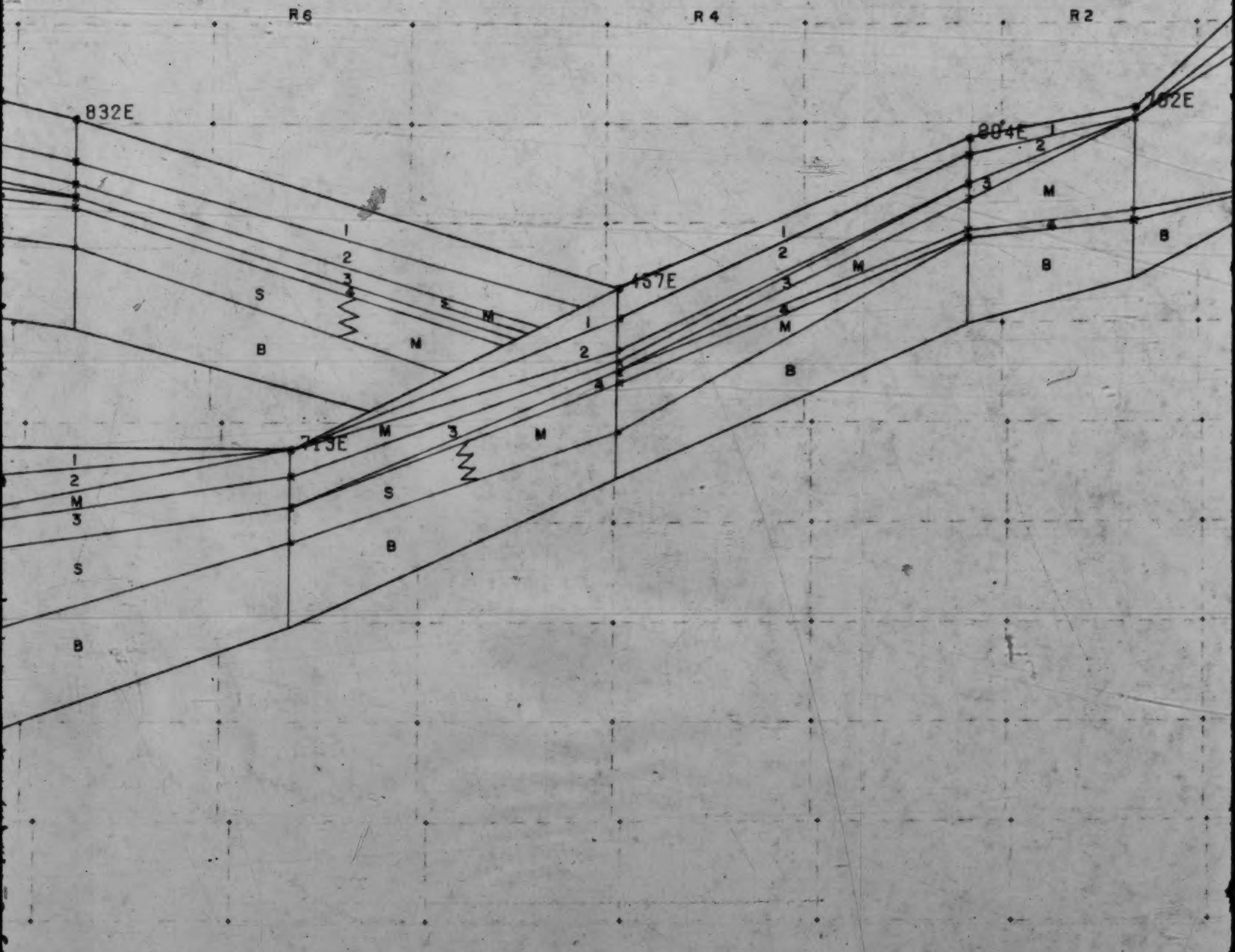
1
2
3
4
808E
R8
R6
832E
2
4
S
1
2
3
M
4
S
B
1
2
3
4
S
M
B
M
798E
713E
M
3
756E
1
1
2
M
3
S
S
2
2
3
3
S
B
B
M
M
S
B
B

LEGEND

1	Till unit 1	S	Sand &/or gravel
2	Till unit 2	L	Lacustrine silt & clay
3	Till unit 3	B	Bedrock sandstone or shale
4	Till unit 4	M	Mixed sand, lacustrine, bedrock or till

Fig.

Fence
bedroc
study

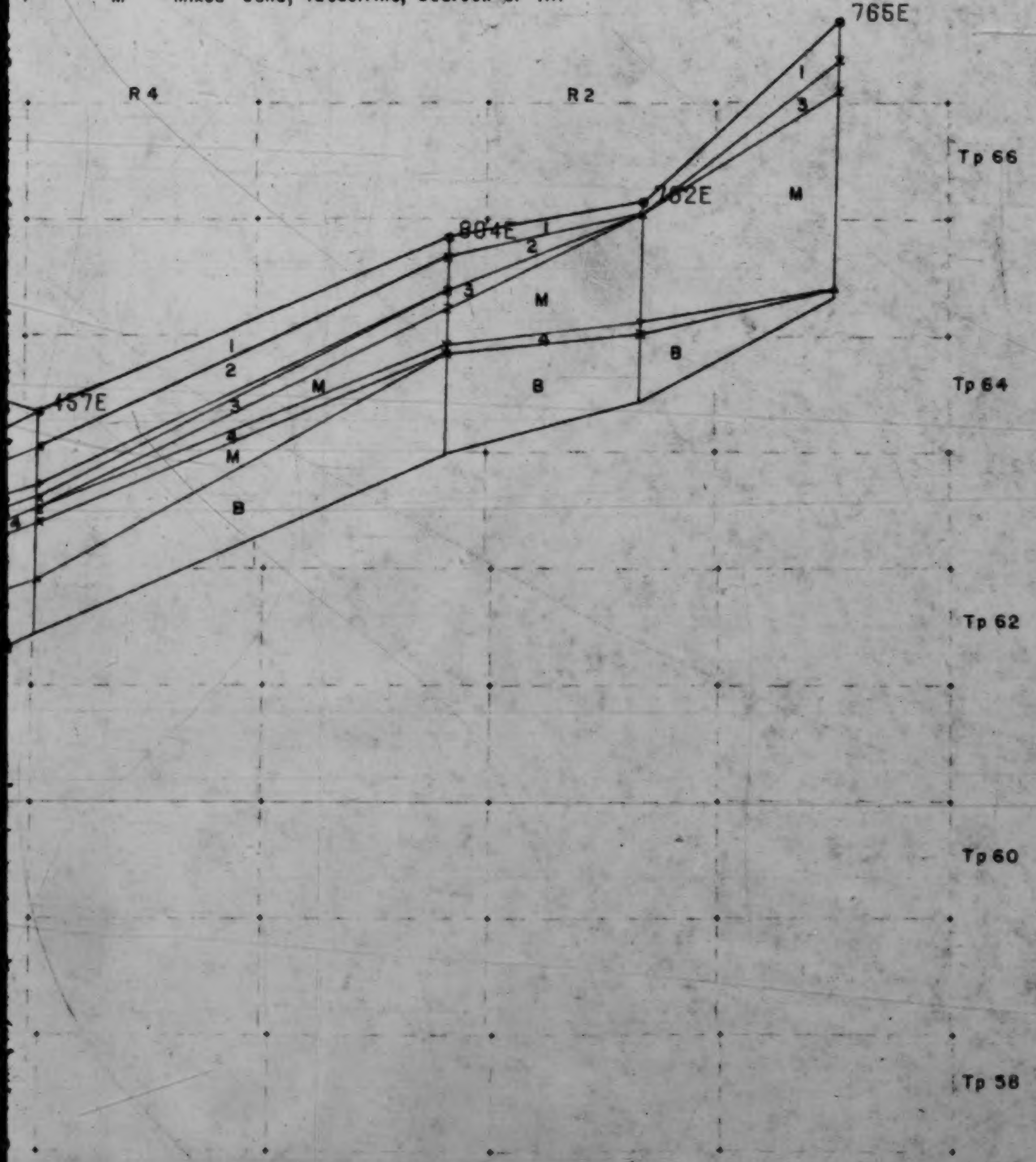

R6
R4
R2
832E
457E
804E
82E
713E
1
2
3
4
S
B
M

LEGEND

1	S	Sand & /or gravel
2	L	Lacustrine silt & clay
3	B	Bedrock sandstone or shale
4	M	Mixed sand, lacustrine, bedrock or till

Fig. 49

Fence diagram along the bedrock channels of the study area.


765E
762E
804E
457E
R 4
R 2
Tp 66
Tp 64
Tp 62
Tp 60
Tp 58
1
2
3
4
M
B

9.4 Middle Till Deposition

Fig. 50 shows the elevation of the top of the lower till. There is no evidence of major drainage in the area, although local streams may have flowed east to Cold Lake. Neither extensive leaching nor clear zones of oxidized iron associated with this till are found in the Sand River area. Fig. 51 shows the inter-till deposits directly below the middle till, consisting mainly of valley-fill deposits near Cold Lake, and Fig. 52 shows the pre-middle till surface. As seen from Fig. 53, the thickness of the middle till is greatest in the old Beverly Channel and at the top of the St. Lina slope, to the west of which it was not found in the drill-holes. This thickening, along with its topographic expression as shown in Fig. 54, suggests the formation of an end-moraine, possibly the Altamont of Rutherford (1941). Fig. 55 shows the inter-till deposits below the upper till - the four patches of thick deposits are clearly deposits whose true age is older but can not be so identified due to the absence of the required till layer at that location. Fig 56 shows the topography at the base of the upper till, and most of the weathered zones located are associated with this surface, indicating an extended ice-free period. There is no obvious drainage pattern.

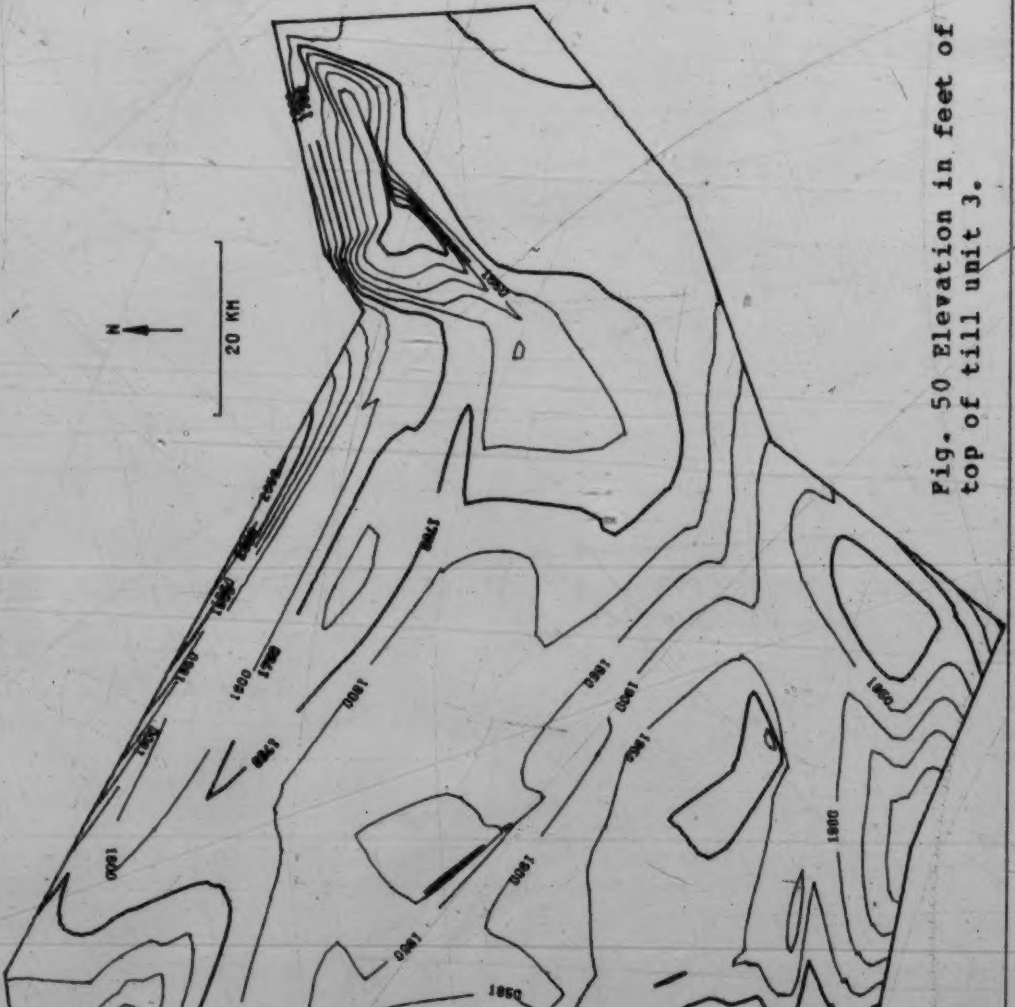

N
20 KM
1700
1750
1800
1850
1900
1950
2000

Fig. 50 Elevation in feet of the top of till unit 3.

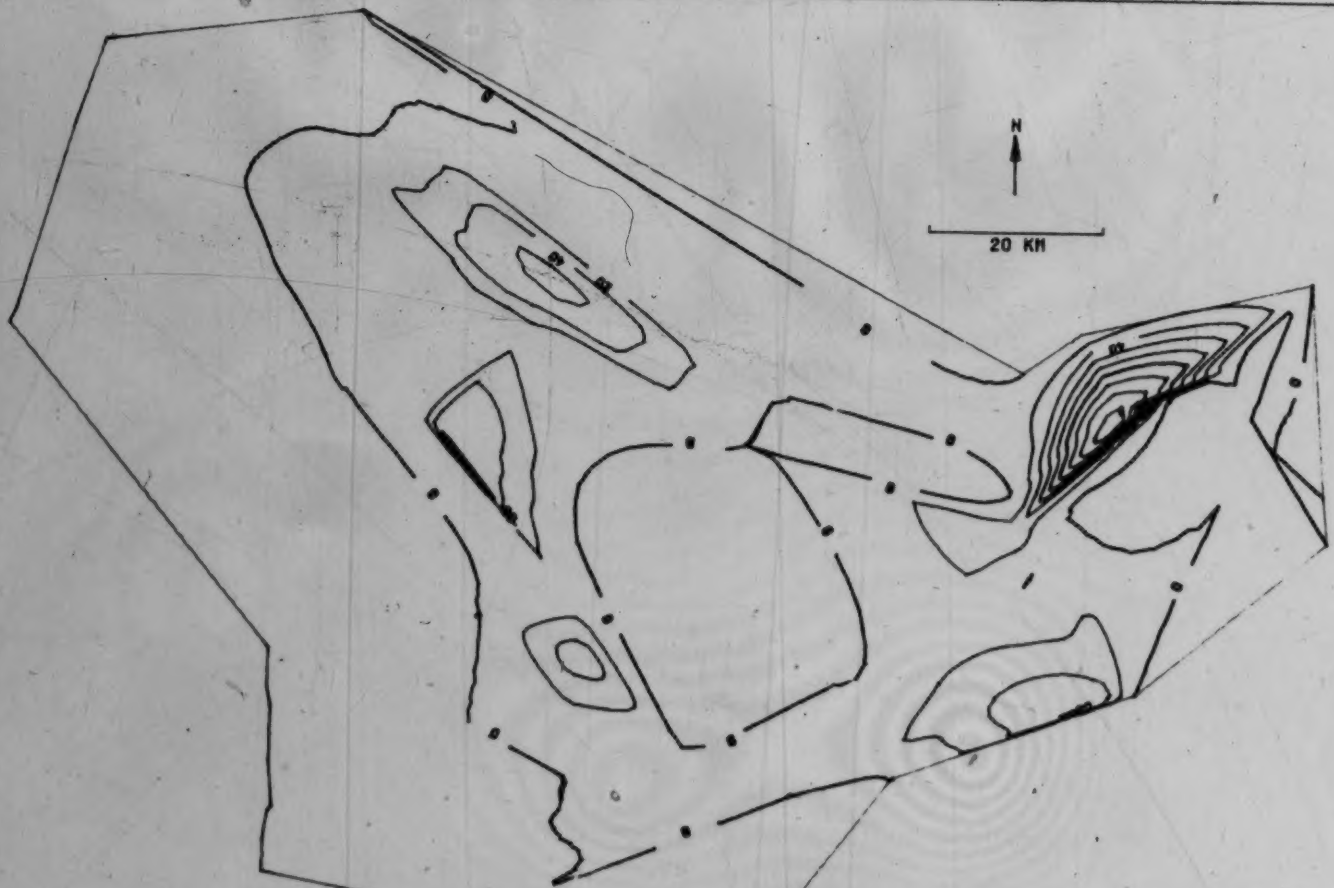


Fig. 51 Thickness in feet of unconsolidated deposits immediately underlying till unit 2.

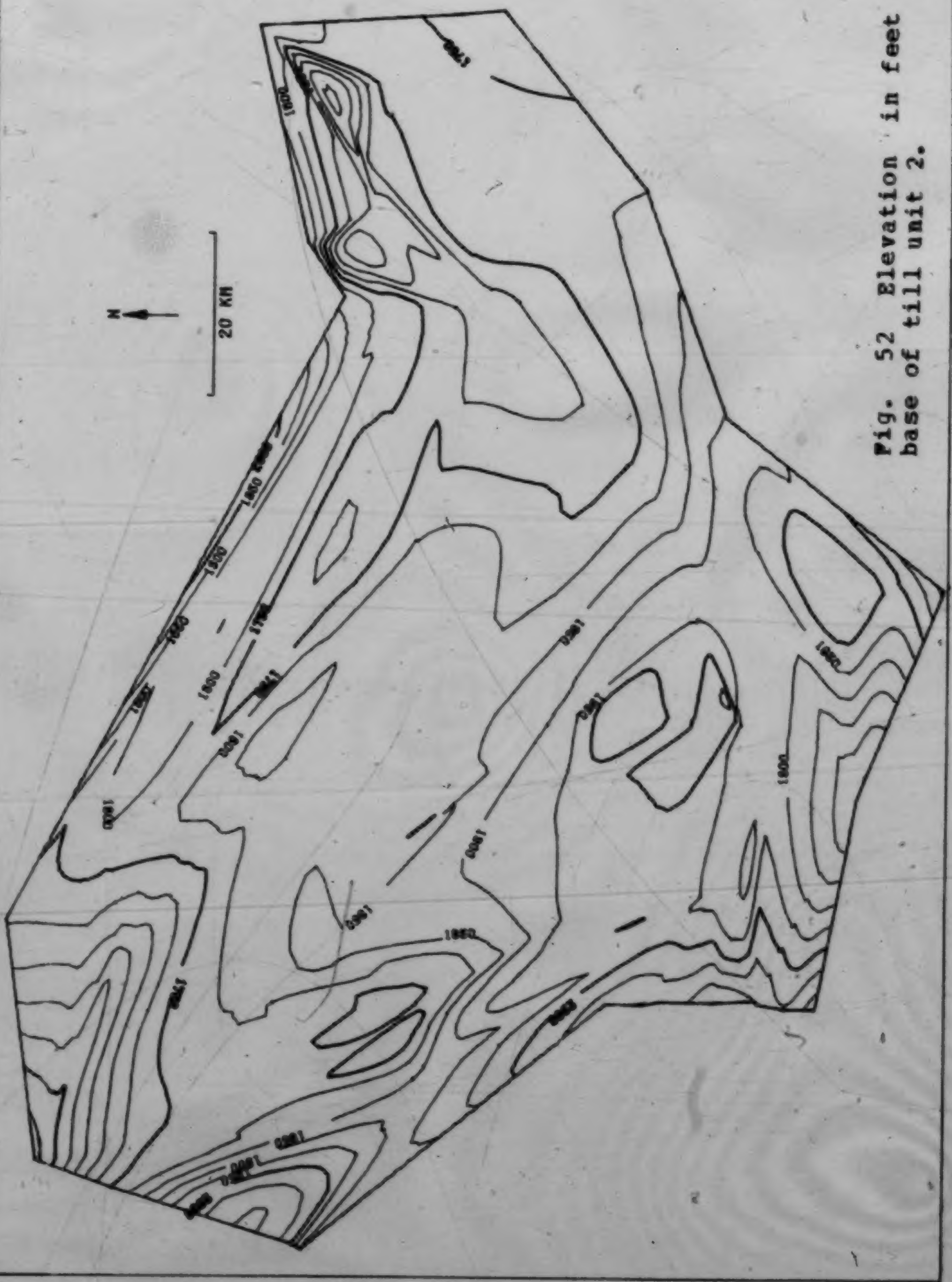

N
20 KM
1800
2000
1900
1850
1700

Fig. 52 Elevation in feet of the base of till unit 2.

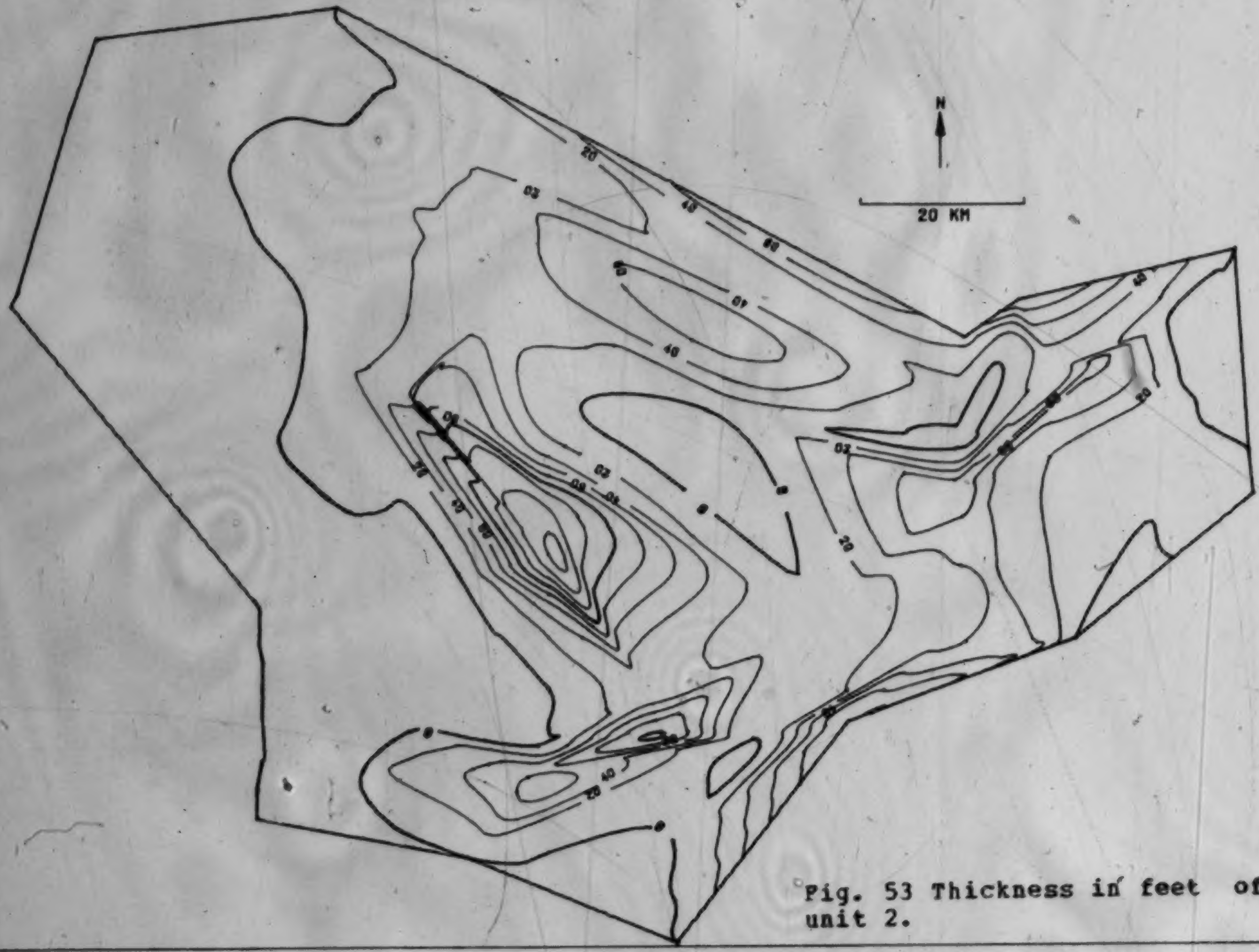

N
20 KM
0
20
40
60

Fig. 53 Thickness in feet of till unit 2.

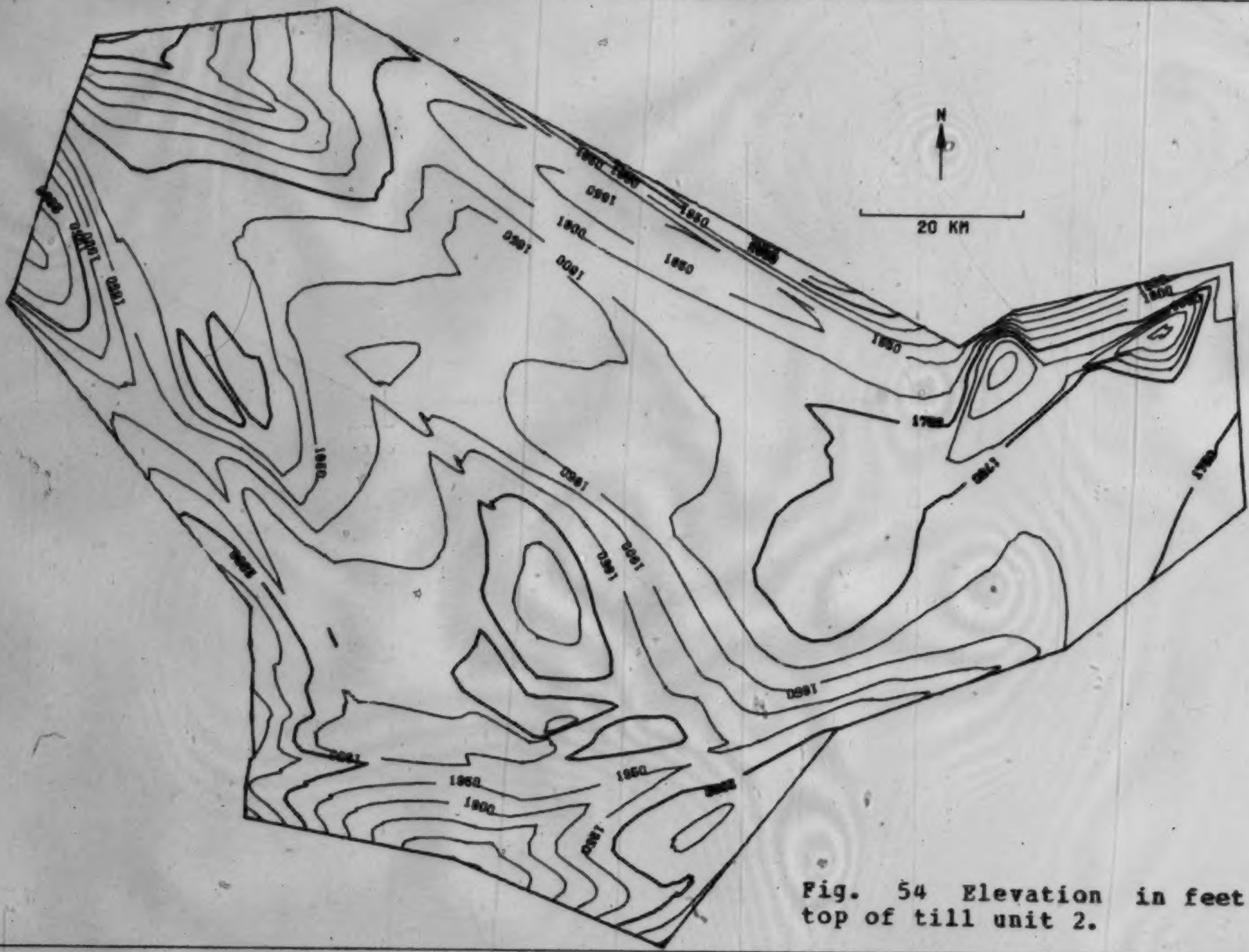

N
20 KM
1800
1850
1750

Fig. 54 Elevation in feet of the top of till unit 2.

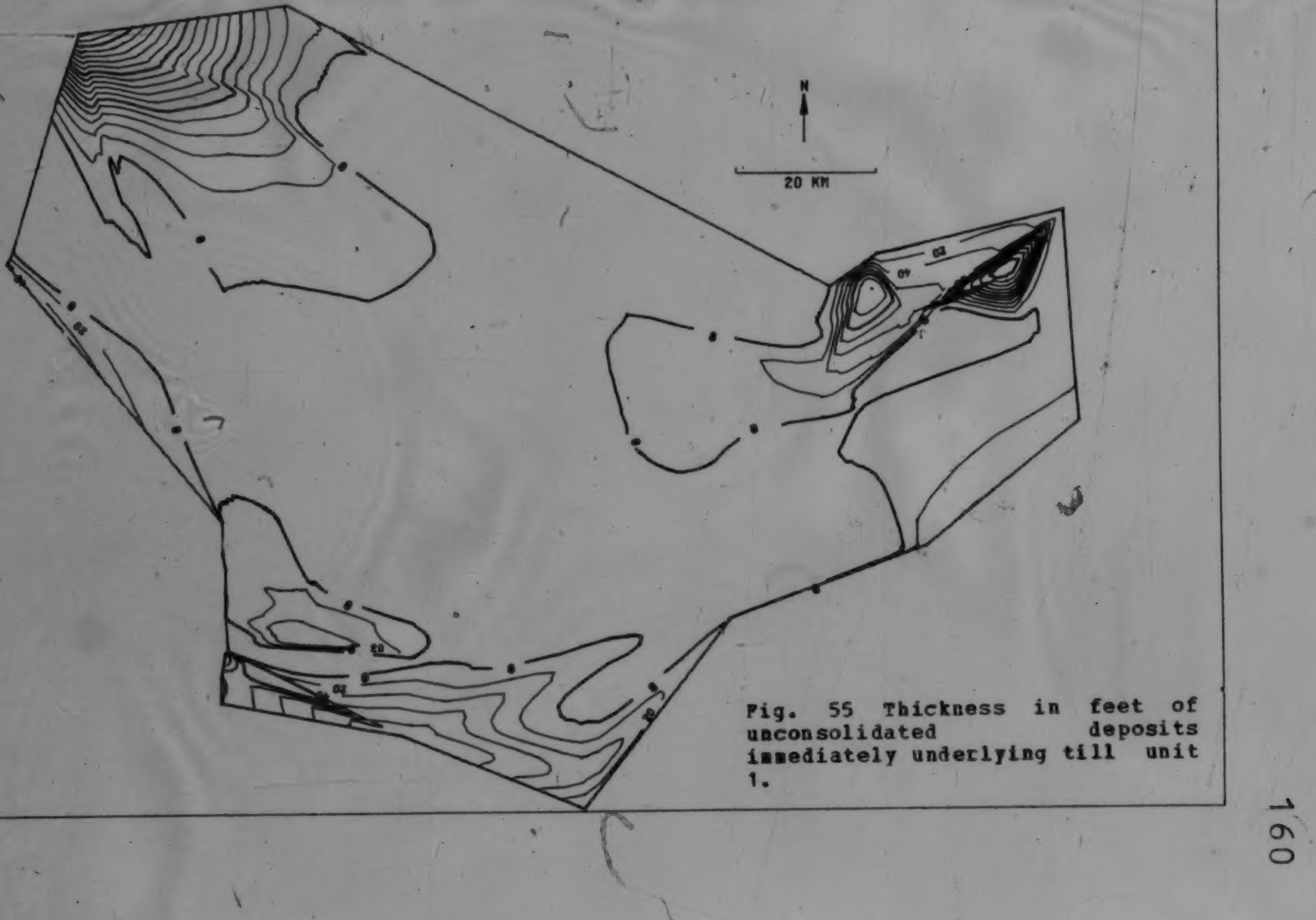

N
20 KM
20
40
20
20
20
20

Fig. 55 Thickness in feet of unconsolidated deposits immediately underlying till unit 1.

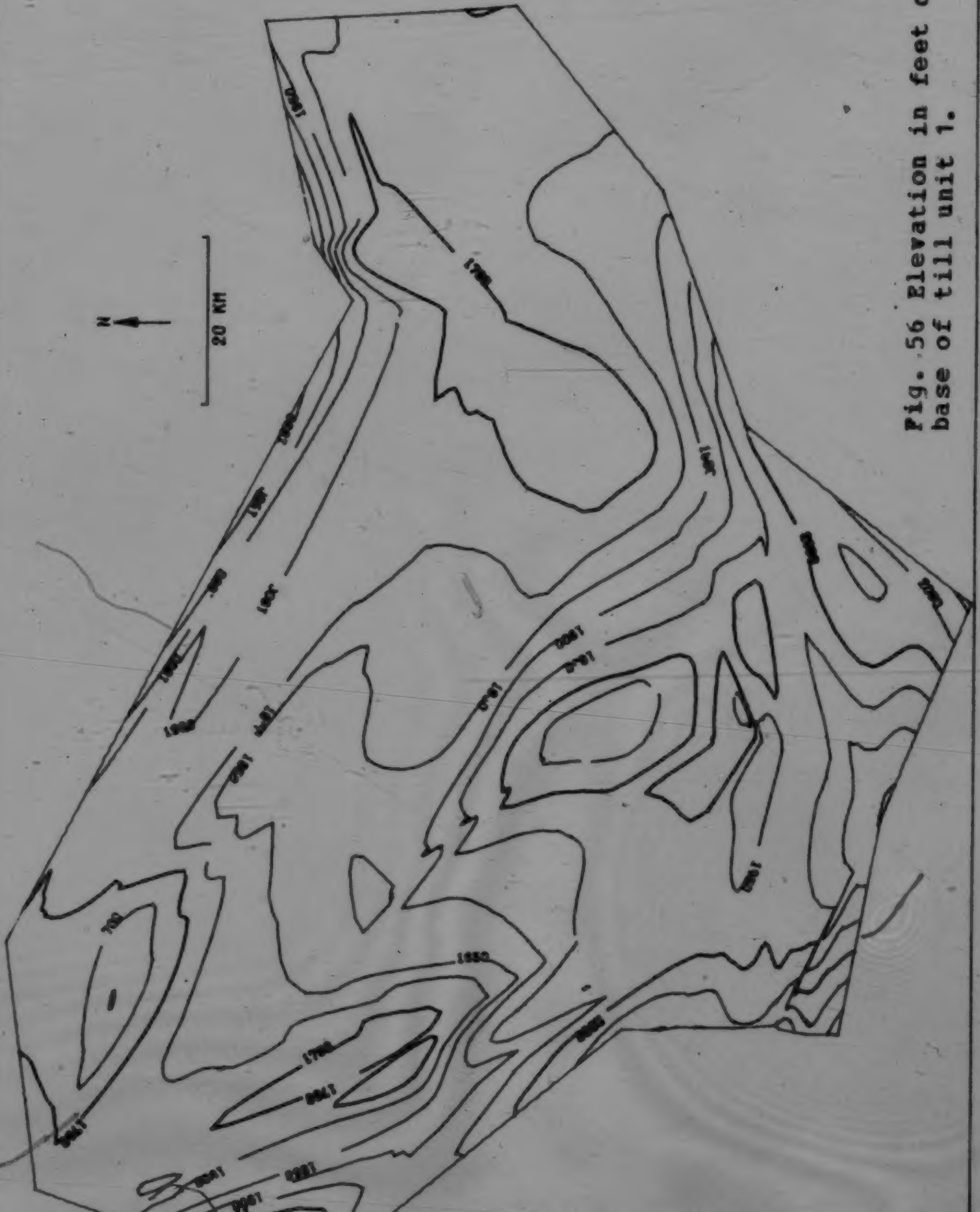

N
20 KM
1700
1800

Fig. 56 Elevation in feet of the base of till unit 1.

9.5 Upper Till Deposition

Fig. 57 shows the thickness of the upper till, which extends over the whole area, and also continues further to the west. The predominant effect is of further deposition of till to reduce irregularities in the underlying terrain, together with a tendency for the till to thicken at the western edge of the map area where the ice met the higher ground.

9.6 Present Topography

Fig. 58 shows the elevation of the top surface of the upper till. It suggests that little major drainage passes through the area, although as shown on Fig. 59 and Fig. 2, (the generalized map of the present topography), a broad vestigial valley is still found following the Helina Channel between Lac La Biche and Cold Lake. The current rivers, primarily the Amisk, Beaver, and Sand Rivers, are relatively small with very localized drainage basins. A minor low region, occupied by Whitefish, Goodfish and Garver Lakes remains as evidence of the Kikino Channel and its effect on ice movement, but little evidence of the Beverly Channel remains. Indeed, a conspicuous neck of high ground still crosses the channel between Vilna and Wahstao, evidence of the magnitude of the Vilna bedrock thrust. Just upstream from this barrier, St. Onge (1972) noted a system of meltwater channels that may have drained the North Saskatchewan River to the north at one stage in the retreat

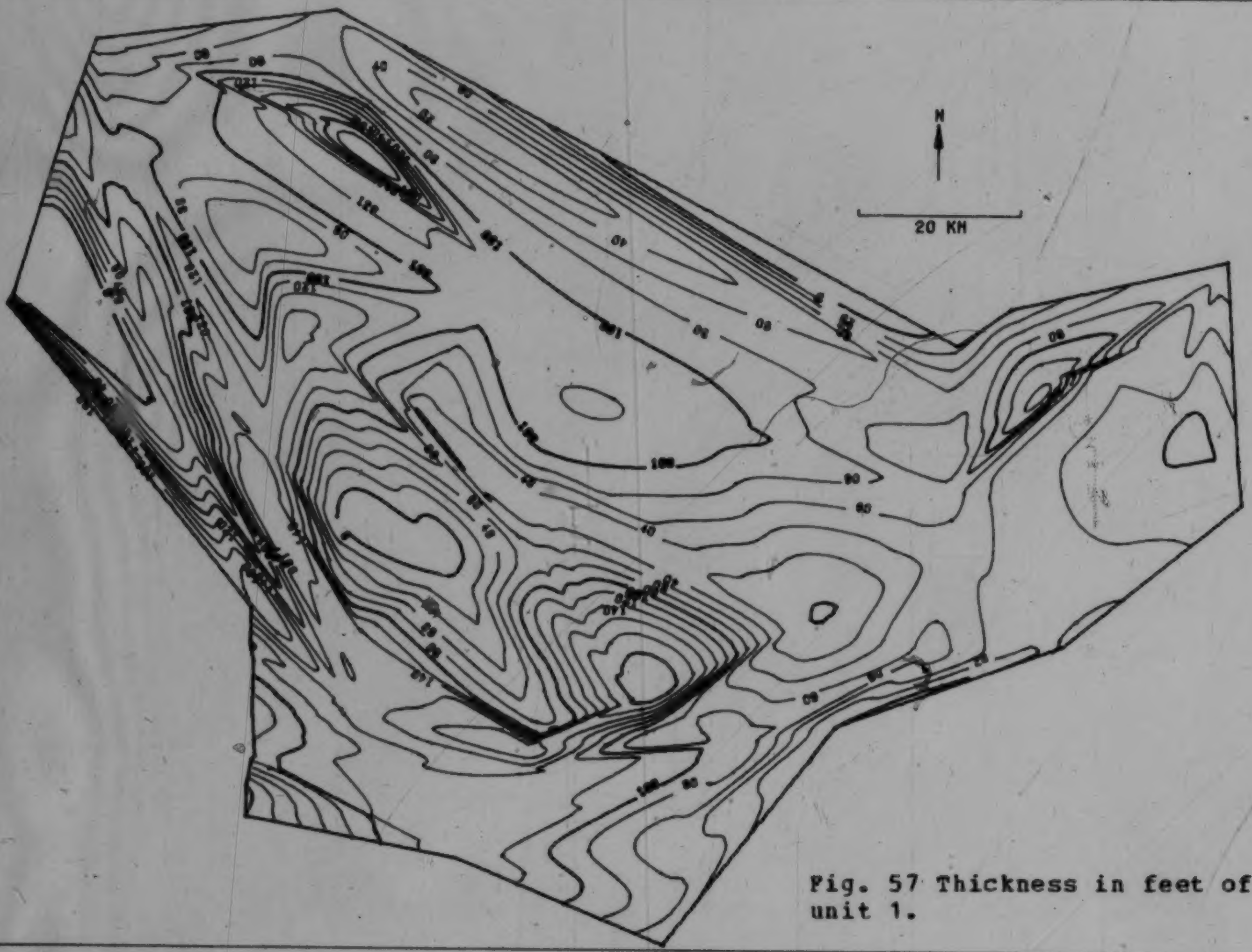

N
20 KM
40
80
100
120
140

Fig. 57 Thickness in feet of till unit 1.

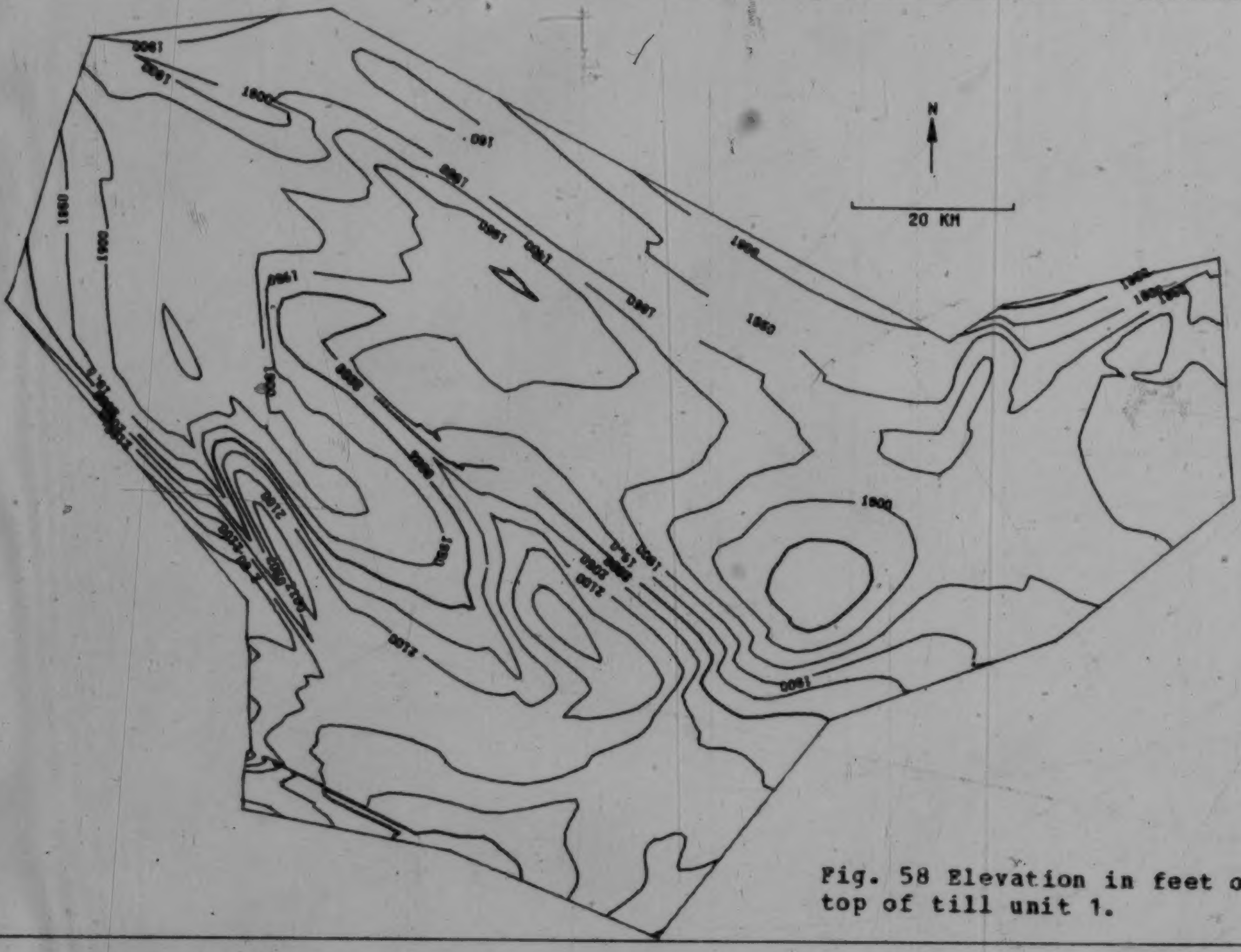

N
20 KM
1800
1850
1900
2000
2050
2100

Fig. 58 Elevation in feet of the top of till unit 1.

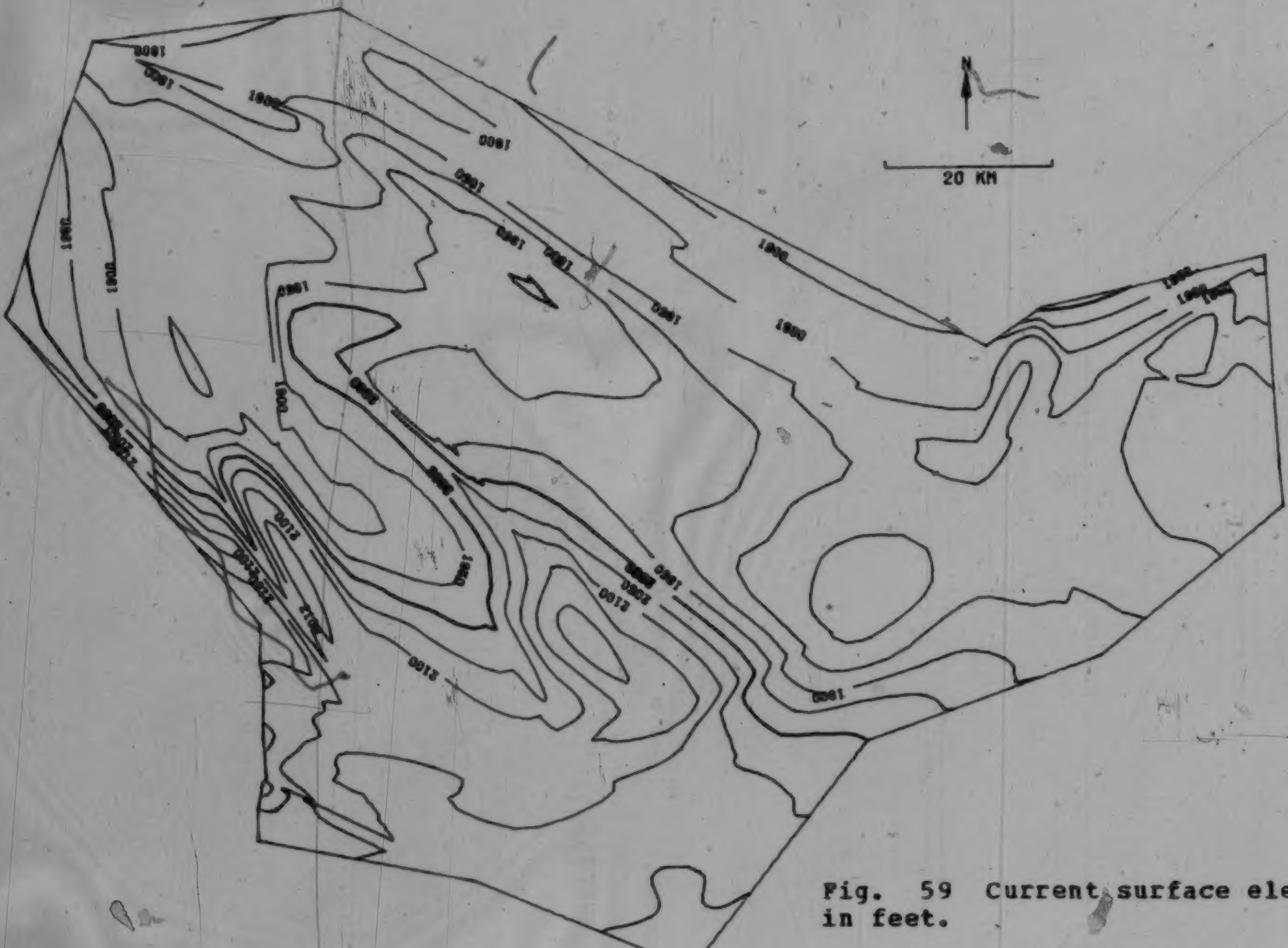

N
20 KM
1800
1900
2000
2100

Fig. 59 Current surface elevation in feet.

of the most recent glaciation. Ellwood (1961) suggested a deglaciation sequence for the Vermillion area to the south that takes into account the meltwater channels in that area, as well as the late-stage remobilization of stagnant ice that produced the south-east trending flutings that are such a conspicuous feature on air-photographs. At an even later stage of deglaciation, Kocaoglu (1975) noted glacio-lacustrine deposits just below the junction of the Beverly and Kikino channels, and fluvio-glacial deposits slightly further upstream.

9.7 Historical Summary

The glacial history of the area may be summarized with reference to the fence diagram of Fig. 49.

1/

The preglacial North Saskatchewan and Athabasca Rivers flowed east through the Beverly and Helina channels, joining in the eastern part of the map area.

2/

Glacial ice advanced into the map area from the north-east, depositing till unit 4 in the eastern part of the map area and disrupting the regional drainage. The North Saskatchewan River, being dammed, was diverted north, cutting the Kikino Channel. The Athabasca River was probably diverted north, out of the map area, at this time.

3/

The ice retreated to the east, and while the North Saskatchewan may have resumed its old course, abandoning the Kikino Channel, the Athabasca did not re-occupy the Helina Channel within the map area.

4/

After what may have been a relatively short time interval the ice readvanced into the area and deposited till unit 3. In the process of overriding the newly formed Kikino Channel bedrock thrusting occurred, completely blocking the Beverly Channel upstream from its junction with the Kikino Channel, forcing the North Saskatchewan to cut its present channel to the south. It is not known how far the ice extended to the west of the Kikino Channel.

5/

Following the retreat of the ice an indeterminate period of time elapsed before the arrival of the next ice sheet. No major drainage passed through the area.

6/

The new ice advance deposited the distinctive high-carbonate till unit 2 over the eastern half of the area, but apparently did not advance any further to the west.

7/

Following the retreat of this ice sheet an extensive period of time elapsed prior to the advance of the final ice sheet, as indicated by the extensive weathered zone formed in many places on the land surface of that time (Section 7.1).

8/

The final ice advance from the east extended past the western boundary of the map area and deposited till unit 1. After the ice retreated this till formed much of the present topographic surface.

9.8 Correlation of Surficial Units

Christiansen (1968a,b, 1972a,b) and Whitaker and Christiansen (1972) classified the surficial deposits of central Saskatchewan on the basis of drill-hole information. The Empress, Sutherland and Saskatoon Groups established by them are described below.

The Empress Group is defined as those deposits between the bedrock surface and the lowest till, including both preglacial and glacial material. The Sutherland Group consists of the lowest major till and is distinguished from the overlying tills by possessing more clay and less sand, a generally lower electric log resistivity and a lower carbonate content, especially of dolomite. The Sutherland Group can sometimes be separated into an upper member with moderate and a lower member with very low carbonate content. Partial leaching of carbonates is sometimes found in the top 40 feet of the Sutherland Group.

The overlying Saskatoon Group is composed of the lower

Floral till and the upper Battleford till. These are not usually separable on the basis of carbonate content, but the Floral is frequently oxidized towards the top, indicating fairly extensive weathering, and is more compact and jointed (with oxide staining in the joints) than the overlying Battleford till which is more friable, soft and unjointed.

Table 11 shows the tentative correlation between Christiansen's work in Saskatchewan and the results of this study. On the basis of a lower carbonate content, lower electric-log resistivity, frequently lower sand values and the occasional separation into two units, the lower till of the Sand River area is correlated with Christiansen's Sutherland Group, although leaching of carbonates at the top is less obvious in the Sand River area. On the basis of the occurrence of an oxidized weathered zone directly below the upper till, the middle and upper tills of the Sand River area are correlated with the Floral and Battleford tills respectively. It should be noted that frequently in Christiansen's published cross-sections the Floral till does in fact have a rather higher carbonate content than the Battleford. In agreement also is the somewhat higher Mg content in the upper till of the Sand River area by comparison with the lower till.

With respect to carbonate values it should be noted that Christiansen's cross-sections tend to be parallel to ice-front positions and therefore approximately equidistant from the source of the erratic carbonate. Hence he does not

Saskatchewan Christiansen (1968a,b, 1972a,b) Whitaker and Christiansen (1972)		Alberta This Study		
Saskatoon Group	Battleford Till	Upper Till		1
	(Oxidized)	(Oxidized)		
	Floral Till	Middle Till		2
	(Partially Leached)			
Sutherland Group	Upper member	Lower Till	Upper member	3
	Lower member		Lower member	4
Empress Group		? Sands and gravels	(Glacial) (Preglacial)	
Bedrock		Bedrock		

Table 11. Tentative correlation of surficial units between Saskatchewan and Alberta.

specifically consider the decrease in carbonate content with distance from the source. In the Sand River area however, the main channels are roughly parallel to the ice flow direction and the effect of diluting the erratic carbonate with local shales is marked. This may well be due to relatively high erosion of local material due to the regional uphill slope facing the advancing ice.

10.0 CONCLUSIONS

10.1 Requirements for Stratigraphic Correlation

It has been shown in this work that it is possible to decipher the till lithostratigraphy and broad glacial history of an area from drill-hole information. The tools required are primarily the traditional ones of driller's and electric logs. The visual examination of cuttings or side-wall samples is nct enough, and some compositional data are required. Different tills probably differ in composition in most areas because succeeding glaciations mask or expose different portions of bedrock, and the earlier tills themselves may be incorporated in the younger ones.

10.2 Choice of Compositional Measurements

Analysis of various compositional parameters indicates that many tills are remarkably homogeneous throughout their thickness, notwithstanding the occasional textural variation or sand lens that is apparent from the electric log. This is especially true of the silt and clay fraction in the present study. Lateral variation is less consistent, being affected by local sub-ice conditions and topography, although systematic dilution of erratic materials is evident away from their source. Compositional parameters should therefore be chosen from the fine rather than the coarse fraction of the till, since more individual grains will usually be analyzed in a procedure performed on a fine fraction. Total sand content is frequently useful in separating till units within the drill-hole, as is the electric resistivity log. Compositional parameters in the fine material heavily reflect the ratio of erratic to local material, and in this study, as in others, calcium carbonate equivalent has proved to be the most concise summary of this, as well as being one of the easiest analyses to perform.

10.3 Sampling Methodology

On the basis of the plots in Appendix 4, a few empirical suggestions may be made on sample collection in the field. Several samples should be taken from each suspected till unit since a single sample may not be representative. When plotted in the fashion of Appendix 4, four samples will probably visually indicate the average composition of the till unit. The sampling decision would normally be made in the field on the basis of the previously-run electric log. Breaks in the general trend of the resistivity curve frequently denote a new lithologic unit and form a good basis for field sampling decisions. Samples every 5 feet are recommended for thin units, and every 20 or more feet for very thick tills. Deeper tills should be sampled at least as carefully as more shallow ones.

10.4 Regional Stratigraphy

Four possible tills have been identified in the study area. Several of them may be regional in extent, as has been shown in Saskatchewan. It is suggested that Christiansen's (1968a,b, 1972a,b) nomenclature for surficial deposits (Empress, Sutherland and Saskatoon Groups; Floral and Battleford Formations) be used whenever the interpretation seems justified.

10.5 Hydrology

Till stratigraphy has some benefit for estimating the hydrologic potential at various depths in an area. Sand or gravel layers are less likely to occur within a till than between tills, and if present are less likely to be laterally continuous. The zone between the lowest till and bedrock has a higher potential for water supply than the overlying tills, especially if associated with a bedrock valley. Inter-till sands are also fairly extensive, but usually tend to be less clean. Aquifers are most likely to be found in depressions in the surface on which they were formed - whether in a bedrock valley or a superimposed till surface. A basic understanding of the glacial stratigraphy and history should therefore facilitate the estimation of groundwater potential.

10.6 Analytic and Display Techniques

Techniques for bulk carbonate analysis, bulk chemistry of the fine fraction of till samples, and the computer display of contour maps have been developed for this study. In each case these developments appear to be tools the use of which extends beyond this work. The equipment developed is a step in the direction of automated laboratory carbonate analysis in both surficial geology and soil science. Bulk chemical analysis on fused till samples is currently dependent on the availability of an electron microprobe, but should soon be a viable technique on the more common, and less expensive, electron microscope when fitted with a suitable detector for energy-dispersive analysis. In terms of the rate of analysis of multiple elements and samples the method compares favourably with other available techniques.

Finally, the developments in automated contour mapping described here provide both facilities and economies not previously available. The approach outlined has several advantages in terms of flexibility, economy and the properties of the surface representation produced. Future enhancements could easily include slope calculations, automatic hill shading, storage of multiple surfaces (for example, geological contacts) and volumetric and areal calculations. In contrast with many methods the ideas used (i.e. breaking the region into triangles, obtaining the slopes at each data point and bending triangular plates to conform to these) are easy to comprehend, if not always easy to implement, and hence the casual user should not receive any unpleasant surprises in the form of outrageous costs or surface shapes along with his desired map.

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APPENDIX 1

Formal Laboratory Procedures

Initial Sample Preparation

Crush air-dried sample.

(Due to lengthy storage the sidewall samples are usually extremely hard. Consequently coarse crushing should be done with a jaw crusher followed by hand crushing with a rolling pin to avoid breaking rock fragments. Continue hand crushing until little new material passes through a #40 sieve.)

Sieve on #40 sieve (using "Sonic Sifter" for one minute at setting 6). Weigh and record the +40(A) and -40(B) fractions.

Wash +40 fraction on a #40 sieve and oven-dry.

Sieve on #10, #20 and #40 sieves using Sonic Sifter. Weigh and record the +10(C), +20(D) and +40(E) fractions.

Store -40 and total +40 fractions.

Grain Counts

Sieve +40 fraction on +10 and +20 sieves. Use -10, +20 fractions.

If necessary, partition sample by quartering until at least 200 grains are left in the pile. Categorize 200 grains as local shale or sandstone, acid igneous, basic igneous, carbonate or undifferentiated quartz. Record number of grains in each category, recombine and store +40 fraction.

Grains Size Analysis

Sieve -40 fraction using #230 sieve until 5 to 10 gm of -230 fraction are obtained. Weigh and record. Place this sample in approximately 250 ml of Calgon solution (40 gm Calgon per litre distilled water), agitate and leave overnight to soak. 12 to 24 samples may be prepared at one time.

Distilled water should be kept at room temperature.

Wash sample into soil dispersion mixer with a small amount of distilled water. Mix at low speed for two minutes and high speed for one.

Wash sample back into jar with distilled water, make up to 400ml, agitate thoroughly and place on solid surface. Record starting time.

Calculate settling time for 2 micron fraction to fall 4 cm at room temperature using Stokes' Law. Assuming a particle density of 2.65, T in minutes = 10^6k^2 where K=0.01365 at 20°C.

At end of settling time insert the pipette to the 4 cm mark below the surface of the liquid. Siphons off 25 ml, place in a weighed bottle and oven-dry.

Record dry weight of the aliquot after subtracting the weight of the bottle and the weight of Calgon in a blank aliquot.

Wash remaining sample in a #230 sieve. Oven dry +230 fraction.

Sieve on #60, #140 and #230, sieves. Weigh and record the -40 +60(H), -40 +140(I) and -40 +230(J) fractions.

Since it is necessary to use small samples and to extract some of the -230 fraction for further analysis, data reduction is as follows:

- a correction factor due to loss of -230 fraction, k = 1+(A-E)/B is calculated.
- the fine fractions (H,I,J) are multiplied by k.
- the silt + clay weight = k(A-J).
- the clay weight = volume of sample suspension x clay aliquot weight / aliquot volume.

Carbonate Analysis

Power on the carbonate apparatus, and allow 10 minutes for the detector to stabilize. The recorder should be set at approximately 5 volts full scale and 8 minutes per inch.

Obtain 1 gm of sample by quartering the preserved -230 fraction and place it in the rinsed acrylic flask. Put 10 ml of 50% HCl in the reservoir, add a magnetic stirring bar, screw down the lid and allow the internal pressure to stabilize for a minute.

Invert flask to mix acid and sample. Place flask upright on magnetic stirrer set to about half speed.

Remove flask and unscrew lid when chart curve indicates no further pressure rise. Measure and record pressure rise due to the sample above the pressure in the uninverted sealed flask.

Run 5 calibrations of 200 mg oven-dryed (105°c) calcium carbonate reagent at least once a day, or if marked barometric changes occur.

Calculate % calcium carbonate equivalent for each sample assuming the average pressure change of a batch of calibrations to be due to 20% of calcium carbonate.

Bulk Chemistry - Sample Preparation

Obtain approximately 2 gm of preserved -230 fraction by quartering. Place in clean vial with 2 parts by volume of lithium tetraborate flux. Mix and pour into a clean crucible. Compact sample by tapping and invert onto graphite holder.

Place sample in image furnace, turn furnace up to 60 volts and allow sample to melt for 10 minutes. Remove sample, quench and break off tip of sample. Place in epoxy mount made by drilling 12 3/16" holes through a 1" disc of Araldite with a polyethylene ("Saran Wrap") film on one side. Record sample position. Fill mount with epoxy and leave 2 days to cure.

Grind on paper lap using #240 and #400 sandpaper.

Re-impregnate surface with 3M epoxy. Place in a vacuum for 10 minutes. Heat in oven at 110° C for 3 hours or overnight at 72°-75° C.

Grind briefly on #600 sandpaper, then wash it carefully with soap and water.

Impregnate mount with Geonite and wash with warm water.

Grind on paper using 6,3 and 1 micron diamond paste for

1, 1 and 3 hours respectively. Wash and re-impregnate with Geonite between paste changes.

Clean mount thoroughly, polish with .05 micron alumina for one minute, wash with warm water and soap.

Carbon coat mounts.

Bulk Chemistry - Analysis (University of Alberta Installation)

Place mounts in the ARL-AMX electron microprobe equipped with an Ortec lithium-drifted silica energy dispersive detector. Standards to be used are Kakanui kaersutite for Na, Mg, Al and Ca, quartz for Si, Hohenfels sanidine for K and ilmenite for Ti and Fe. These must be analyzed at the beginning of each run, and a calibration willemite standard should be processed at the beginning and end of the day's run. Instrument settings are 15 kV operating voltage, 300 nanoamps beam current and 8 microns scanning diameter for the beam. Beam current and probe current readings should be taken every hour with the Faraday cage.

Eight regions of each glass should be counted for 50 seconds each, for a total of 400 seconds per sample. Data is collected on the Texas Instruments 733 cassette tape terminal, and the saved data transmitted to the Amdahl 470/V6 computer for processing through the EDATA energy dispersive data-reduction program.

APPENDIX 2

Calcium carbonate equivalence and grain size analyses for all analyzed samples.

The absolute values of the clay figures are considered to be unreliable due to disaggregation problems, although useful for comparison with neighbouring samples.

Samples are identified by drill hole number and depth in feet.

Hole/Depth		CaCO3	Cumulative - Percentages										
		Equiv.	Sand (Sieve intervals)					%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
			10-20	10-40	10-60	10-140	10-230						
434E	5	2.5	4.47	10.83	21.69	38.60	46.71	92.18	100.00	1.15	46.71	45.47	7.82
434E	10	6.9	4.12	10.31	19.14	34.05	40.32	95.66	100.00	2.17	40.32	55.34	4.34
434E	15	7.8	3.46	10.48	24.42	50.05	61.03	84.95	100.00	0.62	61.03	23.92	15.05
434E	20	6.4	4.96	12.82	16.63	21.53	23.20	90.02	100.00	7.50	23.20	66.83	9.98
434E	25	6.6	4.17	11.23	21.39	39.01	46.47	89.52	100.00	1.90	46.47	43.05	10.48
434E	30	7.2	4.50	12.26	22.67	41.64	45.76	91.16	100.00	2.20	45.76	45.40	8.84
434E	35	8.6	3.46	9.65	20.17	38.53	45.71	90.01	100.00	2.35	45.71	44.29	9.99
434E	45	7.5	3.50	10.38	21.54	37.95	45.00	86.92	100.00	2.79	45.00	41.92	13.08
434E	50	8.3	3.65	9.97	20.99	38.46	46.03	92.13	100.00	4.24	46.03	46.10	7.87
434E	55	5.5	3.39	10.62	21.96	41.40	49.18	90.19	100.00	2.66	49.18	41.01	9.81
434E	60	3.8	3.27	10.74	18.85	34.05	38.99	92.25	100.00	1.02	38.99	53.25	7.75
434E	135	7.2	1.81	5.26	11.08	26.46	33.52	94.21	100.00	0.50	33.52	60.69	5.79
434E	140	6.3	1.97	6.48	12.47	23.87	30.19	91.95	100.00	0.62	30.19	61.76	8.05
434E	145	6.7	1.33	4.47	9.53	19.79	25.74	88.98	100.00	1.32	25.74	63.25	11.02
434E	150	7.6	0.82	2.88	6.36	13.50	19.48	84.73	100.00	0.25	19.48	65.25	15.27
434E	155	6.5	1.37	4.20	9.34	18.59	25.73	91.26	100.00	0.50	25.73	65.53	8.74
435E	10	4.9	3.52	10.42	20.53	38.76	46.72	91.39	100.00	1.50	46.72	44.68	8.61
435E	20	6.1	3.55	9.80	18.58	34.59	41.01	89.85	100.00	3.23	41.01	48.84	10.15
435E	30	5.1	3.03	9.09	17.92	34.89	42.35	88.78	100.00	1.30	42.35	46.43	11.22
435E	40	7.5	4.10	11.02	21.11	39.96	45.69	93.23	100.00	1.43	45.69	47.55	6.77
435E	50	7.2	3.42	10.56	21.43	39.23	46.15	94.18	100.00	2.48	46.15	48.03	5.82
435E	55	6.6	3.07	9.18	18.34	37.44	43.64	93.18	100.00	2.18	43.64	49.54	6.82
435E	60	8.4	3.00	8.83	17.41	40.78	48.28	93.62	100.00	1.79	48.28	45.34	6.38

Hole/Depth		CaCO3	- - - - - - - - - Cumulative - Percentages - - - - - - - - -										
		Equiv.	- - - - Sand (Sieve intervals) - - - - - -					%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
			10-20	10-40	10-60	10-140	10-230						
435E	70	6.3	4.04	11.49	22.58	41.00	50.30	93.85	100.00	1.72	50.30	43.55	6.15
435E	80	4.8	3.57	10.46	20.52	37.43	44.10	88.49	100.00	2.70	44.10	44.39	11.51
435E	90	2.8	2.95	8.04	17.34	31.49	38.32	89.44	100.00	0.39	38.32	51.12	10.56
435E	100	3.3	1.91	7.11	15.88	29.66	36.24	93.98	100.00	0.80	36.24	57.74	6.02
435E	110	4.4	2.38	7.82	20.36	34.67	40.00	90.18	100.00	6.00	40.00	50.19	9.82
435E	120	3.4	2.49	8.17	17.23	31.46	38.35	92.93	100.00	0.93	38.35	54.58	7.07
435E	130	2.1	2.16	7.17	16.08	32.60	39.44	93.33	100.00	0.78	39.44	53.89	6.67
435E	140	2.3	3.64	10.47	18.83	33.64	40.22	94.97	100.00	0.80	40.22	54.75	5.03
435E	160	2.9	2.32	7.74	17.30	34.53	41.79	95.76	100.00	0.40	41.79	53.97	4.24
435E	170	2.5	2.19	7.25	16.63	35.59	42.31	92.78	100.00	0.34	42.31	50.47	7.22
435E	172	2.7	3.35	10.54	23.15	40.71	46.26	92.37	100.00	4.80	46.26	46.11	7.63
435E	180	3.0	1.19	5.14	14.56	31.47	37.78	91.77	100.00	0.30	37.78	53.99	8.23
435E	190	2.8	2.26	7.99	16.19	34.32	41.85	93.49	100.00	1.12	41.85	51.64	6.51
435E	200	6.0	3.59	10.20	17.37	30.13	35.89	88.44	100.00	3.20	35.89	52.55	11.56
435E	210	4.7	4.27	11.66	19.88	35.51	42.14	96.08	100.00	1.85	42.14	53.94	3.92
435E	220	3.4	2.30	7.22	15.59	31.05	37.62	87.36	100.00	1.03	37.62	49.74	12.64
435E	250	2.7	1.13	4.42	10.77	23.78	29.53	82.59	100.00	0.12	29.53	53.06	17.41
435E	252	2.6	1.44	5.16	11.15	25.14	34.30	83.22	100.00	2.00	34.30	48.91	16.78
435E	260	3.1	1.61	5.22	12.02	24.40	30.80	83.48	100.00	0.70	30.80	52.69	16.52
435E	270	2.6	0.27	1.16	5.24	25.60	35.07	70.33	100.00	0.01	35.07	35.26	29.67
435E	290	6.1	2.99	8.29	15.71	29.47	36.39	88.91	100.00	0.93	36.39	52.52	11.09
435E	310	5.2	2.58	7.82	14.01	27.96	34.65	88.44	100.00	1.75	34.65	53.80	11.56
435E	320	5.4	2.56	6.09	12.14	25.00	32.42	83.86	100.00	5.03	32.42	51.44	16.14
435E	330	2.6	7.51	14.08	20.01	30.17	35.29	87.70	100.00	2.49	35.29	52.42	12.30
435E	340	4.5	2.02	5.61	12.32	25.51	32.78	87.09	100.00	1.30	32.78	54.31	12.91

Hole/Depth		CaCO3	Cumulative - Percentages										
		Equiv.	Sand (Sieve intervals)					%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
			10-20	10-40	10-60	10-140	10-230						
435E	345	4.5	1.56	4.79	12.18	26.72	33.66	90.83	100.00	0.30	33.66	57.18	9.17
436E	10	4.2	3.49	9.05	16.64	32.47	40.12	90.29	100.00	6.00	40.12	50.17	9.71
436E	20	5.4	2.08	5.10	13.03	32.41	39.92	86.89	100.00	3.69	39.92	46.97	13.11
436E	30	5.7	3.34	9.43	18.85	35.64	42.91	87.61	100.00	4.20	42.91	44.70	12.39
436E	40	8.0	3.72	10.84	21.63	40.44	47.62	91.50	100.00	2.14	47.62	43.87	8.50
436E	50	6.5	5.43	12.88	23.18	41.47	48.80	89.29	100.00	10.67	48.80	40.49	10.71
436E	60	7.8	4.56	11.66	22.73	38.71	44.00	89.52	100.00	6.37	44.00	45.52	10.48
436E	70	6.8	4.09	11.72	22.26	40.62	47.50	89.26	100.00	3.19	47.50	41.77	10.74
436E	80	6.5	2.62	7.62	19.46	38.50	43.57	90.78	100.00	4.40	43.57	47.21	9.22
436E	85	6.1	3.54	9.99	21.32	40.05	46.16	87.09	100.00	2.50	46.16	40.93	12.91
436E	90	6.6	4.10	10.83	21.93	39.80	46.79	86.68	100.00	1.23	46.79	39.89	13.32
436E	95	6.8	3.89	10.73	20.92	37.77	45.29	88.26	100.00	1.78	45.29	42.97	11.74
436E	100	3.4	1.90	6.43	14.80	30.53	37.48	88.09	100.00	1.18	37.48	50.61	11.91
436E	110	3.4	2.15	6.96	14.63	30.65	36.29	88.66	100.00	0.60	36.29	52.37	11.34
436E	130	4.1	2.74	7.85	16.55	32.66	39.17	89.81	100.00	1.82	39.17	50.65	10.19
436E	150	3.6	2.23	6.99	14.59	31.72	37.49	88.89	100.00	1.00	37.49	51.40	11.11
436E	195	2.8	2.51	7.09	15.79	31.58	36.01	92.06	100.00	1.39	36.01	56.04	7.94
437E	5	7.0	2.16	7.18	15.90	34.32	40.87	88.41	100.00	0.90	40.87	47.55	11.59
437E	35	6.3	5.81	13.10	23.62	40.74	47.86	89.91	100.00	2.41	47.86	42.05	10.09
437E	45	8.1	4.16	8.00	12.44	32.58	39.07	88.83	100.00	10.49	39.07	49.77	11.17
437E	55	4.8	2.55	8.36	9.29	17.75	40.73	89.64	100.00	0.60	40.73	48.91	10.36
437E	65	4.4	4.83	13.38	21.95	37.57	43.72	92.07	100.00	6.83	43.72	48.36	7.93
437E	75	7.1	2.78	8.29	8.86	17.35	40.03	92.76	100.00	1.22	40.03	52.73	7.24

Hole/Depth		CaCO3 Equiv.	Cumulative - Percentages										
			Sand (Sieve intervals)					%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
			10-20	10-40	10-60	10-140	10-230						
437E	85	5.4	3.45	8.95	19.41	36.41	41.02	91.24	100.00	1.62	41.02	50.22	8.76
437E	95	6.0	4.63	13.14	28.37	59.32	69.75	89.17	100.00	1.82	69.75	19.43	10.83
437E	105	5.1	2.96	8.74	19.35	33.54	38.27	92.28	100.00	1.85	38.27	54.00	7.72
437E	117	5.5	3.66	10.97	21.51	38.11	45.34	09.96	100.00	1.23	45.34	44.62	10.04
437E	125	6.3	4.05	11.00	23.83	43.16	48.84	90.68	100.00	0.89	48.84	41.84	9.32
437E	140	8.0	2.80	11.16	22.59	41.15	48.28	91.41	100.00	1.79	48.28	43.14	8.59
437E	150	7.2	3.48	8.63	20.77	39.01	43.65	93.46	100.00	0.90	43.65	49.81	6.54
437E	160	6.9	4.59	11.24	22.19	40.95	46.67	89.67	100.00	4.40	46.67	43.01	10.33
437E	170	6.7	1.83	5.06	15.76	33.61	39.47	91.64	100.00	3.50	39.47	52.17	8.36
437E	180	3.9	2.48	7.10	14.13	30.18	36.71	93.37	100.00	1.29	36.71	56.67	6.63
437E	190	4.0	3.61	10.43	19.69	32.64	37.24	94.49	100.00	1.43	37.24	57.25	5.51
437E	200	4.1	2.66	7.91	16.76	30.94	37.89	93.04	100.00	1.90	37.89	55.15	6.96
437E	210	3.7	2.41	7.25	16.15	32.25	38.14	94.00	100.00	0.90	38.14	55.86	6.00
437E	232	3.0	4.05	11.18	19.92	34.46	40.31	95.67	100.00	7.00	40.31	55.36	4.33
437E	240	4.1	1.98	6.33	15.76	29.56	34.66	88.26	100.00	3.39	34.66	53.61	11.74
437E	260	3.5	1.00	2.63	5.03	9.62	11.89	88.19	100.00	0.83	11.89	76.30	11.81
439E	5	9.5	10.83	4.80	9.80	26.38	37.73	89.91	100.00	0.45	37.73	52.18	10.09
439E	10	4.6	2.19	7.86	17.41	32.45	37.75	90.51	100.00	0.85	37.75	52.75	9.49
439E	20	5.7	3.24	9.31	19.27	35.39	41.88	88.47	100.00	2.23	41.88	46.59	11.53
439E	30	4.6	2.55	7.48	15.44	30.09	35.94	93.49	100.00	0.62	35.94	57.55	6.51
439E	40	8.2	3.84	10.82	20.08	40.37	44.63	92.26	100.00	1.10	44.63	47.64	7.74
439E	50	7.3	2.98	9.19	19.16	38.16	43.83	93.15	100.00	3.18	43.83	49.32	6.85
439E	60	8.1	3.70	10.69	21.38	41.53	45.12	92.56	100.00	1.90	45.12	47.44	7.44
439E	70	7.2	3.01	10.87	22.68	39.90	46.34	95.11	100.00	3.50	46.34	48.77	4.89

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Hole/Depth		CaCO3	- - - - - - - - - Cumulative - Percentages - - - - - - - - -										
		Equiv.	- - - - Sand (Sieve intervals) - - - - - -					%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
			10-20	10-40	10-60	10-140	10-230						
439E	80	8.7	4.22	11.64	21.99	40.53	46.52	93.17	100.00	2.20	46.52	46.66	6.83
439E	90	7.2	3.83	10.55	23.28	43.17	47.91	91.96	100.00	1.95	47.91	44.05	8.04
439E	100	7.8	3.92	11.01	24.52	43.44	47.65	93.76	100.00	3.80	47.65	46.11	6.24
439E	108	12.6	4.40	11.34	21.14	39.23	44.36	93.05	100.00	7.20	44.36	48.69	6.95
439E	118	2.6	2.91	8.38	16.83	37.62	45.98	90.34	100.00	0.92	45.98	44.36	9.66
440E	10	4.3	3.88	9.87	16.63	28.27	32.16	84.69	100.00	1.92	32.16	52.53	15.31
440E	20	7.9	4.58	12.15	20.85	49.03	56.22	90.45	100.00	2.69	56.22	34.23	9.55
440E	30	4.7	3.64	9.82	17.15	38.56	43.27	87.72	100.00	1.30	43.27	44.45	12.28
440E	40	6.2	2.66	8.22	15.27	33.17	38.94	94.00	100.00	1.00	38.94	55.07	6.00
440E	50	3.8	3.36	9.66	20.11	37.40	43.22	90.52	100.00	1.50	43.22	47.29	9.48
440E	60	8.4	3.49	9.78	18.61	37.85	42.35	93.83	100.00	2.03	42.35	51.48	6.17
440E	70	2.7	2.34	6.49	11.92	25.95	31.09	88.72	100.00	0.29	31.09	57.63	11.28
440E	80	4.5	1.51	4.58	8.99	34.51	41.22	91.82	100.00	0.43	41.22	50.60	8.18
440E	90	3.4	2.49	7.72	15.55	32.71	37.71	93.18	100.00	1.30	37.71	55.47	6.82
440E	100	4.7	2.49	7.14	14.36	29.07	33.75	91.73	100.00	0.50	33.75	57.98	8.27
440E	110	4.2	2.35	6.89	12.52	27.29	31.37	96.29	100.00	0.62	31.37	64.92	3.71
440E	120	4.3	2.97	7.68	15.01	28.25	33.79	91.94	100.00	0.62	33.79	58.15	8.06
440E	150	4.5	2.65	8.04	16.10	32.40	36.96	94.55	100.00	2.10	36.96	57.59	5.45
440E	170	2.0	2.42	7.37	14.57	31.19	35.02	97.54	100.00	1.78	35.02	62.52	2.46
440E	180	1.1	2.23	7.01	14.11	30.50	36.73	90.49	100.00	1.00	36.73	53.77	9.51
440E	190	2.3	2.44	6.68	12.72	27.23	30.77	98.32	100.00	0.30	30.77	67.55	1.68
440E	210	2.4	1.97	6.57	14.07	32.01	36.04	97.91	100.00	0.48	36.04	61.88	2.09
440E	219	2.7	2.32	7.16	15.30	30.90	37.43	92.53	100.00	0.32	37.43	55.10	7.47
440E	230	4.3	2.00	5.68	11.10	26.10	29.90	95.91	100.00	0.79	29.90	66.02	4.09

Hole/Depth		CaCO3	Cumulative - Percentages										
		Equiv.	Sand (Sieve intervals)					%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
			10-20	10-40	10-60	10-140	10-230						
440E	240	5.3	4.01	8.88	15.90	33.13	39.14	87.03	100.00	6.23	39.14	47.88	12.97
440E	250	4.5	2.31	5.73	11.41	29.51	33.25	94.51	100.00	1.22	33.25	61.26	5.49
440E	256	2.5	1.85	5.39	11.78	29.04	32.42	94.12	100.00	0.90	32.42	61.71	5.88
455E	5	4.8	1.82	5.97	13.30	30.90	33.64	91.61	100.00	0.48	33.64	57.98	8.39
455E	10	3.7	2.90	3.93	8.67	19.03	20.54	89.98	100.00	1.50	20.54	69.44	10.02
455E	15	5.1	1.32	4.30	10.02	22.90	26.34	88.61	100.00	0.39	26.34	62.27	11.39
455E	20	5.0	1.49	4.57	9.80	24.36	27.70	87.60	100.00	0.50	27.70	59.89	12.40
455E	35	13.4	3.46	8.17	14.27	29.95	34.37	90.53	100.00	4.98	34.37	56.16	9.47
455E	50	8.5	4.06	11.70	21.05	36.90	40.76	92.62	100.00	3.75	40.76	51.86	7.38
455E	65	13.8	3.01	6.93	12.06	26.80	31.82	92.40	100.00	3.76	31.82	60.57	7.60
455E	80	15.0	3.38	7.86	13.32	26.09	29.73	90.97	100.00	2.64	29.73	61.24	9.03
455E	95	10.9	3.17	8.34	15.56	31.59	35.56	88.60	100.00	2.62	35.56	53.05	11.40
455E	110	11.1	3.81	9.15	16.76	32.02	36.05	89.23	100.00	1.57	36.05	53.18	10.77
456E	5	3.9	1.38	4.85	10.85	25.78	31.35	87.10	100.00	1.78	31.35	55.75	12.90
456E	15	4.8	0.20	1.12	2.26	4.78	5.46	88.33	100.00	0.31	5.46	82.87	11.67
456E	25	3.6	2.26	7.24	16.55	37.61	42.84	91.48	100.00	0.78	42.84	48.65	8.52
456E	35	5.1	1.66	5.40	12.33	27.20	31.48	86.68	100.00	0.26	31.48	55.21	13.32
456E	40	6.3	2.11	5.86	12.94	27.53	32.42	86.48	100.00	0.50	32.42	54.06	13.52
456E	45	5.8	1.97	5.71	13.04	29.26	35.05	91.89	100.00	0.90	35.05	56.85	8.11
456E	55	6.5	1.12	3.74	8.65	18.29	20.14	91.37	100.00	0.50	20.14	71.23	8.63
456E	65	5.1	1.52	3.99	8.14	16.70	18.62	89.59	100.00	1.37	18.62	70.97	10.41
456E	75	6.5	1.24	3.53	8.09	16.61	18.50	90.87	100.00	0.30	18.50	72.37	9.13
456E	85	6.7	1.86	4.75	10.53	22.43	25.01	90.79	100.00	7.62	25.01	65.79	9.21

Hole/Depth		CaCO3	Cumulative - Percentages										
		Equiv.	Sand (Sieve intervals)					%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
			10-20	10-40	10-60	10-140	10-230						
456E	95	5.9	1.32	4.28	9.86	21.75	24.52	90.77	100.00	0.73	24.52	66.26	9.23
456E	120	16.5	4.39	9.69	16.36	33.33	37.97	90.85	100.00	2.35	37.97	52.88	9.15
456E	125	16.2	3.52	8.03	15.27	34.21	39.66	92.54	100.00	2.68	39.66	52.88	7.46
456E	130	6.1	3.32	9.83	19.78	38.47	44.15	95.69	100.00	1.28	44.15	51.54	4.31
456E	135	5.3	4.57	12.35	22.77	42.03	46.00	95.51	100.00	1.66	46.00	49.51	4.49
456E	145	2.7	1.61	7.12	17.30	34.15	37.60	93.22	100.00	0.30	37.60	55.61	6.78
456E	150	2.4	2.00	7.13	15.46	32.91	37.74	93.81	100.00	0.60	37.74	56.08	6.19
457E	10	9.1	2.63	6.86	14.38	35.59	38.63	90.13	100.00	0.82	38.63	51.50	9.87
457E	30	8.4	2.58	7.97	18.52	37.58	40.87	88.53	100.00	2.53	40.87	47.66	11.47
457E	50	9.5	1.61	4.42	10.26	29.30	32.76	89.51	100.00	0.90	32.76	56.75	10.49
457E	60	17.9	4.40	10.01	17.64	36.70	41.97	92.10	100.00	2.40	41.97	50.13	7.90
457E	70	17.7	4.20	10.26	17.62	37.82	44.11	93.23	100.00	2.67	44.11	49.12	6.77
457E	87	16.3	4.66	10.55	18.91	36.63	40.46	90.85	100.00	5.40	40.46	50.39	9.15
457E	100	14.4	3.88	8.95	16.48	35.55	40.62	93.31	100.00	2.80	40.62	52.69	6.69
457E	110	11.5	4.93	11.76	22.53	41.66	47.57	90.59	100.00	1.72	47.57	43.02	9.41
457E	120	10.4	3.53	9.45	18.13	34.72	38.10	89.85	100.00	1.50	38.10	51.75	10.15
457E	130	10.0	3.88	9.84	18.69	35.76	39.77	91.70	100.00	3.80	39.77	51.93	8.30
457E	185	7.1	5.00	14.02	25.96	45.14	49.51	93.72	100.00	1.25	49.51	44.21	6.28
457E	200	6.2	5.20	12.51	23.31	42.71	46.02	93.24	100.00	2.78	46.02	47.22	6.76
457E	210	5.4	6.91	15.28	25.70	39.21	42.68	90.89	100.00	9.80	42.68	48.21	9.11
457E	240	4.6	5.19	12.20	20.43	34.63	39.97	94.47	100.00	0.99	39.97	54.50	5.53
458E	15	8.2	2.96	8.21	15.40	30.16	36.97	88.12	100.00	1.30	36.97	51.15	11.88
458E	25	7.9	1.76	5.08	10.71	23.91	26.71	86.21	100.00	0.72	26.71	59.50	13.79

Hole/Depth		CaCO3	Cumulative - Percentages										
		Equiv.	Sand (Sieve intervals)					%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
			10-20	10-40	10-60	10-140	10-230						
458E	80	6.8	4.90	12.62	21.75	38.05	41.96	90.09	100.00	4.40	41.96	48.13	9.91
458E	185	7.2	4.05	11.53	22.02	42.27	46.93	93.56	100.00	0.41	46.93	46.63	6.44
458E	225	6.9	5.08	13.01	22.69	42.68	46.57	93.81	100.00	10.53	46.57	47.24	6.19
458E	235	6.4	1.00	4.22	12.53	35.79	41.63	92.67	100.00	0.20	41.63	51.04	7.33
458E	255	9.1	4.51	11.03	19.62	34.81	37.86	87.91	100.00	2.20	37.86	50.05	12.09
459E	10	7.3	2.18	6.69	13.34	29.79	33.90	87.34	100.00	1.38	33.90	53.43	12.66
459E	40	8.8	1.61	4.99	11.25	28.56	31.95	88.68	100.00	0.82	31.95	56.73	11.32
459E	60	9.1	1.12	3.32	7.27	22.10	26.41	92.02	100.00	0.72	26.41	65.61	7.98
459E	70	17.7	4.30	9.81	17.72	35.99	40.18	90.77	100.00	6.26	40.18	50.58	9.23
459E	100	9.8	2.24	5.53	12.26	22.72	25.52	85.35	100.00	3.48	25.52	59.83	14.65
461E	5	5.4	1.79	5.76	12.31	28.62	34.20	87.30	100.00	1.19	34.20	53.10	12.70
461E	10	4.4	1.81	6.05	12.71	29.39	35.91	84.76	100.00	0.80	35.91	48.85	15.24
461E	15	3.0	2.14	6.39	13.72	29.08	34.94	84.19	100.00	0.60	34.94	49.25	15.81
461E	20	3.8	2.14	6.69	13.89	31.15	35.07	90.36	100.00	0.50	35.07	55.29	9.64
461E	25	5.9	3.82	7.82	15.74	28.61	34.14	88.26	100.00	5.43	34.14	54.13	11.74
461E	30	4.9	1.58	22.20	28.89	40.78	45.52	86.71	100.00	1.15	45.52	41.19	13.29
461E	35	6.0	1.61	4.78	10.45	25.59	29.84	88.70	100.00	0.58	29.84	58.86	11.30
461E	40	5.4	1.94	5.28	12.76	24.69	29.31	82.02	100.00	0.63	29.31	52.71	17.98
461E	45	5.7	1.70	4.97	12.03	28.24	32.68	87.20	100.00	1.20	32.68	54.52	12.80
461E	50	3.8	1.67	5.75	12.68	29.98	35.88	90.20	100.00	0.10	35.88	54.32	9.80
461E	65	4.4	1.78	4.86	12.28	22.38	25.68	87.17	100.00	0.53	25.68	61.49	12.83
461E	69	5.9	4.12	11.00	24.16	42.23	46.36	92.11	100.00	3.31	46.36	45.75	7.89
461E	75	6.5	2.15	8.14	16.81	31.38	36.01	91.54	100.00	2.23	36.01	55.54	8.46

Hole/Depth		CaCO3	- - - - - - - - - - Cumulative - Percentages - - - - - - - - -										
		Equiv.	- - - - Sand (Sieve intervals) - - - - - -					%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
			10-20	10-40	10-60	10-140	10-230						
462E	5	4.3	1.39	10.30	33.46	65.19	68.45	91.06	100.00	0.03	68.45	22.61	8.94
462E	20	5.1	1.54	5.24	11.87	27.75	31.98	91.51	100.00	0.29	31.98	59.53	8.49
462E	35	5.0	1.93	6.05	11.76	29.77	35.13	91.40	100.00	3.50	35.13	56.27	8.60
462E	50	16.0	3.71	8.87	15.31	30.04	35.34	91.20	100.00	4.78	35.34	55.86	8.80
462E	60	10.1	2.90	7.49	14.06	27.59	31.70	86.81	100.00	4.10	31.70	55.11	13.19
462E	75	13.0	5.07	11.38	19.33	36.19	40.84	91.37	100.00	4.99	40.84	50.52	8.63
462E	90	9.1	3.28	8.12	15.24	27.22	31.26	90.47	100.00	2.49	31.26	59.21	9.53
463E	10	5.[illegible]	2.75	7.70	15.07	32.19	35.76	85.26	100.00	1.10	35.76	49.50	14.74
463E	20	4.8	1.59	5.52	12.91	29.09	32.40	88.71	100.00	0.98	32.40	56.31	11.29
463E	25	5.0	1.69	5.93	13.41	27.88	34.17	83.13	100.00	0.82	34.17	48.96	16.87
463E	30	5.0	2.03	6.02	13.97	27.72	33.52	85.95	100.00	1.03	33.52	52.43	14.05
463E	40	6.2	2.20	5.65	11.75	24.03	27.48	87.41	100.00	0.48	27.48	59.94	12.59
463E	50	5.4	2.11	6.00	13.50	28.11	31.49	87.94	100.00	1.08	31.49	56.45	12.06
463E	60	5.0	1.44	3.00	6.25	22.88	27.61	91.55	100.00	1.03	27.61	63.94	8.45
463E	70	6.1	1.87	5.51	14.16	27.29	32.26	89.65	100.00	1.20	32.26	57.40	10.35
463E	75	6.2	1.65	4.66	10.26	17.41	20.48	83.58	100.00	0.69	20.48	63.10	16.42
463E	80	5.4	4.63	11.29	20.96	37.05	42.00	92.28	100.00	5.78	42.00	50.29	7.72
463E	85	5.0	3.44	9.61	18.67	34.06	38.80	92.16	100.00	2.29	38.80	53.36	7.84
463E	90	5.6	2.79	7.76	16.10	30.03	34.21	90.84	100.00	0.71	34.21	56.63	9.16
463E	95	5.9	2.95	7.55	15.44	27.67	31.92	91.73	100.00	0.47	31.92	59.81	8.27
463E	100	6.1	3.01	7.52	13.57	28.83	30.77	88.31	100.00	1.45	30.77	57.54	11.69

Hole/Depth	CaCO3 Equiv.	- - - - - - - - - Cumulative - Percentages - - - - - - - - -										
		- - - - Sand (Sieve intervals) - - - - - -					%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
		10-20	10-40	10-60	10-140	10-230						
496E 210	5.7	2.49	6.69	12.17	30.29	36.57	93.41	100.00	0.49	36.57	56.84	6.59
496E 250	1.9	2.38	6.97	12.61	23.53	27.56	93.72	100.00	1.23	27.56	66.16	6.28
496E 290	1.8	2.94	9.36	19.46	40.65	45.26	92.19	100.00	0.31	45.26	46.93	7.81
496E 310	1.6	2.47	8.83	20.39	38.85	43.62	91.54	100.00	0.85	43.62	47.91	8.46
496E 330	2.3	1.52	4.85	10.44	24.51	28.07	94.10	100.00	0.25	28.07	66.03	5.90
496E 345	2.4	1.89	5.64	11.79	25.74	30.34	90.04	100.00	1.79	30.34	59.70	9.96
496E 365	3.7	2.42	6.76	14.87	28.93	34.76	91.51	100.00	0.50	34.76	56.76	8.49
497E 30	11.3	4.07	9.22	16.83	30.78	34.50	88.91	100.00	2.98	34.50	54.41	11.09
497E 40	10.1	3.69	9.05	17.08	30.51	35.98	86.90	100.00	1.01	35.98	50.92	13.10
497E 50	7.9	2.10	6.07	11.91	30.21	33.79	89.80	100.00	0.79	33.79	56.01	10.20
497E 80	5.5	1.91	5.84	12.85	29.88	32.58	87.98	100.00	0.20	32.58	55.40	12.02
497E 90	3.7	1.31	4.16	9.23	27.22	31.03	90.06	100.00	0.83	31.03	59.02	9.94
497E 100	5.7	2.35	6.94	15.37	32.24	37.77	88.49	100.00	2.00	37.77	50.73	11.51
497E 110	5.4	1.80	6.41	14.92	34.63	37.64	89.88	100.00	1.40	37.64	52.24	10.12
497E 120	6.4	3.37	6.63	13.28	25.69	30.96	89.36	100.00	0.40	30.96	58.41	10.64
497E 130	12.7	3.69	9.00	17.53	32.06	35.64	88.80	100.00	2.00	35.64	53.17	11.20
497E 140	10.8	3.08	9.11	16.69	29.84	34.90	86.99	100.00	3.20	34.90	52.10	13.01
497E 150	12.8	5.59	12.02	18.12	36.60	42.59	93.37	100.00	9.11	42.59	50.78	6.63
497E 160	12.2	4.76	11.04	18.00	33.51	38.66	94.12	100.00	3.40	38.66	55.46	5.88
497E 170	12.4	3.92	9.24	16.63	34.79	38.31	92.45	100.00	2.23	38.31	54.14	7.55
497E 220	5.3	2.41	6.63	13.64	29.42	32.60	86.56	100.00	1.40	32.60	53.96	13.44
497E 230	5.7	5.20	9.72	15.67	23.53	26.68	86.04	100.00	3.40	26.68	59.36	13.96
497E 240	5.0	0.95	2.75	5.84	13.91	15.64	85.95	100.00	0.35	15.64	70.31	14.05
497E 250	6.8	3.26	9.63	19.21	41.87	48.79	93.21	100.00	0.85	48.79	44.42	6.79

Hole/Depth		CaCO3	Cumulative - Percentages										
		Equiv.	Sand (Sieve intervals)					%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
			10-20	10-40	10-60	10-140	10-230						
497E	260	5.9	4.00	10.44	19.62	39.25	44.41	92.24	100.00	1.17	44.41	47.83	7.76
497E	270	6.4	2.23	6.70	14.11	29.97	36.45	90.78	100.00	0.45	36.45	54.33	9.22
497E	280	5.2	1.13	2.61	6.18	14.68	16.67	84.14	100.00	0.82	16.67	67.47	15.86
497E	290	6.1	1.42	4.15	9.17	17.71	20.76	86.74	100.00	0.49	20.76	65.98	13.26
497E	295	5.5	1.44	4.81	10.38	22.61	25.46	89.77	100.00	0.29	25.46	64.31	10.23
498E	15	4.2	1.63	5.61	12.98	34.37	37.62	85.48	100.00	1.13	37.62	47.86	14.52
498E	25	4.9	1.81	6.26	19.15	34.25	35.89	93.31	100.00	1.45	35.89	57.42	6.69
498E	40	4.1	1.61	5.87	13.32	30.84	34.18	91.92	100.00	1.10	34.18	57.74	8.08
498E	55	4.2	1.55	5.47	12.37	27.95	30.66	89.81	100.00	0.80	30.66	59.16	10.19
498E	65	4.3	2.61	6.88	13.87	28.96	35.42	87.07	100.00	4.53	35.42	51.65	12.93
498E	70	5.5	1.73	5.60	12.55	28.32	32.27	90.86	100.00	1.01	32.27	58.59	9.14
498E	100	11.2	3.11	7.80	14.69	28.29	31.61	89.33	100.00	2.07	31.61	57.72	10.67
498E	110	9.6	2.41	6.56	12.83	26.02	28.88	96.15	100.00	2.13	28.88	67.27	3.85
498E	120	13.0	3.08	8.03	14.71	28.59	32.97	86.00	100.00	3.79	32.97	53.04	14.00
498E	130	9.8	2.16	6.35	12.78	23.68	27.30	90.14	100.00	0.80	27.30	62.84	9.86
498E	140	12.8	3.03	7.61	13.21	26.34	29.19	89.65	100.00	1.50	29.19	60.46	10.35
498E	150	9.3	4.87	10.04	16.91	31.45	35.99	91.41	100.00	2.80	35.99	55.41	8.59
498E	160	5.0	2.08	6.62	15.71	31.64	37.71	86.41	100.00	1.61	37.71	48.70	13.59
498E	170	8.0	3.47	9.07	15.92	27.70	32.55	89.16	100.00	1.39	32.55	56.61	10.84
498E	180	8.1	2.54	6.56	12.30	25.29	29.36	83.91	100.00	1.39	29.36	54.55	16.09
498E	190	13.4	18.92	35.25	49.35	60.55	63.65	93.84	100.00	6.99	63.65	30.19	6.16
498E	200	11.8	7.74	20.43	42.42	61.03	63.99	93.14	100.00	1.15	63.99	29.15	6.86
498E	250	10.8	3.84	9.38	17.07	31.74	35.01	82.54	100.00	3.13	35.01	47.53	17.46
498E	265	6.3	3.73	8.75	17.81	32.81	35.60	89.07	100.00	2.40	35.60	53.47	10.93

Hole/Depth		CaCO3 Equiv.	Cumulative - Percentages: Sand (Sieve intervals) 10-20	10-40	10-60	10-140	10-230	%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
498E	270	7.2	2.94	6.28	12.60	26.01	31.31	89.41	100.00	1.20	31.31	58.10	10.59
498E	275	6.8	2.62	7.63	17.03	37.21	41.20	88.33	100.00	0.79	41.20	47.14	11.67
498E	280	7.1	1.42	4.52	9.26	18.79	22.70	88.98	100.00	0.79	22.70	66.28	11.02
498E	290	6.6	2.08	5.74	12.10	24.23	27.09	86.00	100.00	0.82	27.09	58.92	14.00
706E	50	5.6	3.92	10.80	20.97	37.83	44.86	90.61	100.00	3.42	44.86	45.75	9.39
706E	60	3.7	3.51	10.87	12.82	15.06	17.01	82.22	100.00	1.20	17.01	65.21	17.78
706E	70	6.1	3.98	11.66	23.53	41.01	47.29	96.24	100.00	1.59	47.29	48.95	3.76
706E	80	6.2	1.98	6.81	14.15	34.29	45.87	91.71	100.00	1.50	45.87	45.84	8.29
706E	100	7.3	3.36	10.89	20.96	37.78	45.11	90.07	100.00	1.10	45.11	44.96	9.93
706E	110	7.2	4.54	12.46	23.33	37.80	42.41	88.17	100.00	10.08	42.41	45.76	11.83
706E	120	5.9	3.04	9.43	19.42	42.19	49.81	89.74	100.00	3.52	49.81	39.93	10.26
706E	125	7.0	4.19	11.82	22.70	37.99	43.44	87.80	100.00	7.70	43.44	44.35	12.20
706E	130	7.5	3.76	11.08	22.05	39.52	45.35	89.69	100.00	2.90	45.35	44.34	10.31
706E	200	7.9	3.53	10.59	20.61	35.38	41.91	91.43	100.00	0.80	41.91	49.53	8.57
706E	210	4.3	2.23	6.82	13.77	25.30	32.08	88.06	100.00	0.80	32.08	55.98	11.94
706E	220	5.1	2.90	7.86	14.83	26.88	34.34	87.79	100.00	0.71	34.34	53.45	12.21
706E	230	4.3	2.79	8.10	15.19	29.10	35.46	86.00	100.00	1.40	35.46	50.53	14.00
706E	240	3.5	2.05	7.31	15.07	29.51	35.91	88.81	100.00	0.92	35.91	52.90	11.19
706E	250	3.7	1.10	3.71	7.53	26.83	41.38	86.68	100.00	0.30	41.38	45.30	13.32
706E	260	5.6	3.53	9.23	16.22	30.87	37.52	87.20	100.00	0.30	37.52	49.68	12.80
706E	270	3.3	2.09	6.67	14.34	29.63	37.55	87.26	100.00	1.40	37.55	49.71	12.74
706E	280	2.9	2.21	6.97	15.40	29.50	36.71	87.33	100.00	1.49	36.71	50.62	12.67
706E	290	3.6	1.53	5.68	12.85	28.10	36.48	88.40	100.00	0.42	36.48	51.92	11.60

Hole/Depth		CaCO3	Cumulative - Percentages										
		Equiv.	Sand (Sieve intervals)					%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
			10-20	10-40	10-60	10-140	10-230						
706E	325	3.4	2.41	8.34	15.97	29.08	37.04	89.69	100.00	6.11	37.04	52.65	10.31
706E	345	2.8	2.20	7.50	15.30	29.90	39.41	90.35	100.00	0.89	39.41	50.94	9.65
706E	348	3.4	1.76	6.61	15.37	28.57	35.44	84.56	100.00	3.30	35.44	49.12	15.44
706E	360	2.9	2.40	7.79	17.98	31.70	38.30	83.76	100.00	2.88	38.30	45.46	16.24
709E	10	6.9	1.19	3.39	15.90	33.90	41.24	85.58	100.00	0.49	41.24	44.35	14.42
709E	20	5.2	5.56	17.20	23.50	32.62	37.50	78.40	100.00	1.91	37.50	40.90	21.60
709E	30	6.1	3.55	10.00	20.70	36.91	43.76	87.75	100.00	2.80	43.76	43.99	12.25
709E	40	7.2	3.23	9.55	20.82	37.19	43.99	90.44	100.00	1.28	43.99	46.44	9.56
709E	50	7.4	4.05	10.65	21.87	38.58	45.33	89.23	100.00	4.00	45.33	43.91	10.77
709E	60	7.0	3.33	9.50	20.09	35.27	41.85	90.06	100.00	1.71	41.85	48.21	9.94
709E	70	7.5	3.91	10.22	22.11	38.79	45.46	89.18	100.00	6.70	45.46	43.72	10.82
709E	80	9.1	3.30	9.05	19.64	34.15	40.28	85.86	100.00	4.09	40.28	45.57	14.14
709E	90	9.6	2.89	8.01	17.63	30.91	36.32	89.58	100.00	0.60	36.32	53.26	10.42
709E	100	2.9	3.57	10.66	22.20	37.04	43.59	87.27	100.00	2.30	43.59	43.68	12.73
709E	110	3.0	3.50	10.62	22.83	38.22	45.16	88.13	100.00	2.10	45.16	42.97	11.87
709E	120	2.8	4.11	12.03	24.13	41.04	48.16	88.32	100.00	2.39	48.16	40.15	11.68
709E	130	3.7	2.70	10.13	22.68	39.67	47.62	92.68	100.00	2.90	47.62	45.05	7.32
709E	140	3.6	4.05	11.63	25.37	42.24	49.72	94.97	100.00	5.18	49.72	45.25	5.03
709E	150	3.6	2.65	8.76	19.64	33.65	40.02	92.96	100.00	1.20	40.02	52.94	7.04
709E	160	3.8	2.06	5.59	12.68	22.42	36.17	86.94	100.00	2.79	36.17	50.77	13.06
709E	170	3.5	3.02	8.74	20.08	35.73	42.01	89.65	100.00	2.30	42.01	47.65	10.35
710E	5	6.6	2.19	7.85	17.95	39.21	46.45	86.82	100.00	0.70	46.45	40.36	13.18

Hole/Depth		CaCO3	Cumulative - Percentages										
		Equiv.	Sand (Sieve intervals)					%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
			10-20	10-40	10-60	10-140	10-230						
710E	90	7.0	3.39	11.01	21.05	35.65	42.04	85.20	100.00	0.30	42.04	43.16	14.80
710E	95	6.9	6.83	15.53	28.51	43.95	50.08	94.95	100.00	1.50	50.08	44.87	5.05
710E	110	6.9	3.92	11.10	22.26	39.01	45.58	91.55	100.00	1.31	45.58	45.97	8.45
710E	115	6.8	4.28	11.71	23.10	39.38	45.97	90.23	100.00	4.32	45.97	44.26	9.77
710E	120	5.8	3.31	9.95	21.94	38.03	44.54	91.91	100.00	0.39	44.54	47.37	8.09
710E	125	7.0	4.63	12.88	25.40	40.49	46.98	92.82	100.00	2.53	46.98	45.84	7.18
710E	130	6.6	3.97	11.19	22.43	37.93	44.20	93.14	100.00	3.70	44.20	48.94	6.86
710E	135	6.9	4.83	12.51	23.92	39.58	46.12	93.53	100.00	1.05	46.12	47.42	6.47
710E	140	7.0	3.91	11.31	22.86	38.01	44.33	92.77	100.00	5.18	44.33	48.44	7.23
710E	145	6.9	5.29	11.99	23.41	38.98	45.95	94.34	100.00	9.20	45.95	48.39	5.66
710E	150	6.6	4.60	12.92	25.18	40.51	46.99	91.58	100.00	11.50	46.99	44.59	8.42
710E	155	6.5	2.80	9.24	19.87	38.41	45.73	92.59	100.00	2.13	45.73	46.86	7.41
710E	160	7.0	4.39	11.37	21.99	37.99	44.91	89.82	100.00	4.23	44.91	44.91	10.18
710E	165	6.8	3.75	10.99	22.60	38.18	45.06	91.36	100.00	0.90	45.06	46.30	8.64
710E	244	7.4	9.30	16.83	28.81	45.20	51.47	92.05	100.00	1.88	51.47	40.58	7.95
710E	273	5.5	5.45	10.44	20.16	44.46	58.41	86.04	100.00	12.91	58.41	27.63	13.96
713E	60	2.8	1.01	2.95	6.56	13.77	20.37	82.18	100.00	0.79	20.37	61.81	17.82
713E	70	8.2	3.45	9.23	21.68	36.87	42.76	88.08	100.00	3.09	42.76	45.31	11.92
713E	80	7.9	2.08	6.76	17.40	31.03	38.22	90.16	100.00	0.75	38.22	51.94	9.84
713E	90	5.0	1.19	3.46	10.91	19.49	23.23	84.83	100.00	1.91	23.23	61.59	15.17
713E	100	7.0	3.05	9.29	23.15	38.15	44.59	92.40	100.00	3.06	44.59	47.82	7.60
713E	110	5.9	2.42	6.80	16.37	29.77	36.33	88.96	100.00	1.81	36.33	52.63	11.04
713E	120	8.1	1.55	4.70	12.25	23.39	27.30	90.03	100.00	1.19	27.30	62.73	9.97

Hole/Depth		CaCO3 Equiv.	Cumulative - Percentages: Sand (Sieve intervals) 10-20	10-40	10-60	10-140	10-230	%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
714E	5	12.6	3.30	8.25	15.45	27.52	32.58	88.47	100.00	1.20	32.58	55.89	11.53
714E	10	11.7	3.14	7.44	14.13	26.74	31.81	86.92	100.00	1.85	31.81	55.11	13.08
714E	15	13.2	3.34	9.68	17.42	29.95	35.87	87.07	100.00	2.14	35.87	51.20	12.93
714E	20	11.6	3.66	8.49	15.45	26.58	31.65	87.07	100.00	2.39	31.65	55.42	12.93
714E	25	13.8	3.03	6.51	14.57	26.01	32.21	87.99	100.00	2.10	32.21	55.78	12.01
714E	30	10.7	3.88	7.42	11.96	19.97	23.76	87.00	100.00	1.31	23.76	63.24	13.00
714E	35	13.1	3.20	7.67	15.21	26.41	31.87	90.00	100.00	4.35	31.87	58.13	10.00
714E	40	12.2	3.36	7.94	14.67	27.08	32.80	90.37	100.00	1.20	32.80	57.58	9.63
714E	45	11.7	3.34	8.64	15.74	27.91	33.29	91.03	100.00	2.91	33.29	57.73	8.97
714E	50	12.9	3.96	8.07	15.99	28.40	33.81	90.79	100.00	2.51	33.81	56.98	9.21
714E	55	11.3	1.73	4.87	13.82	26.20	29.37	89.78	100.00	0.21	29.37	60.41	10.22
714E	60	16.6	4.62	11.30	21.74	43.97	50.17	89.75	100.00	2.69	50.17	39.57	10.25
714E	65	11.2	2.83	7.04	15.04	24.95	29.73	86.95	100.00	0.20	29.73	57.22	13.05
714E	70	12.3	3.86	8.79	15.53	28.08	34.05	88.73	100.00	2.01	34.05	54.68	11.27
714E	75	12.6	4.02	9.18	16.85	28.55	34.15	87.85	100.00	2.30	34.15	53.70	12.15
714E	80	11.9	3.07	7.32	13.31	23.61	28.27	86.11	100.00	2.50	28.27	57.84	13.89
714E	85	16.0	2.18	5.42	10.90	19.36	24.43	89.58	100.00	1.90	24.43	65.15	10.42
714E	90	12.7	2.99	7.28	14.89	24.74	28.54	85.05	100.00	1.17	28.54	56.50	14.95
714E	95	12.3	4.61	9.66	16.62	28.14	33.34	86.08	100.00	12.32	33.34	52.74	13.92
714E	100	6.5	4.18	11.27	23.05	39.44	46.79	91.52	100.00	2.59	46.79	44.73	8.48
714E	105	6.6	3.90	10.29	21.37	36.16	42.77	89.13	100.00	0.40	42.77	46.36	10.87
714E	110	7.0	3.84	10.22	21.17	36.48	43.00	92.99	100.00	2.25	43.00	49.99	7.01
714E	115	5.5	1.96	5.66	11.48	19.83	24.42	91.23	100.00	0.57	24.42	66.81	8.77
714E	120	5.5	2.66	7.00	12.89	23.30	28.18	89.22	100.00	0.81	28.18	61.04	10.78
714E	125	5.1	2.20	5.84	13.05	21.99	26.38	86.89	100.00	0.61	26.38	60.50	13.11

Hole/Depth		CaCO3	Cumulative - Percentages										
		Equiv.	Sand (Sieve intervals)					%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
			10-20	10-40	10-60	10-140	10-230						
714E	130	6.2	2.37	6.34	12.54	22.84	28.11	86.18	100.00	1.18	28.11	58.06	13.82
714E	135	5.1	2.18	7.54	13.61	23.81	28.81	86.82	100.00	0.91	28.81	58.01	13.18
714E	140	4.9	2.30	5.84	12.03	21.85	26.20	89.15	100.00	1.40	26.20	62.95	10.85
714E	145	6.2	1.76	6.41	12.35	22.00	26.84	87.07	100.00	1.09	26.84	60.23	12.93
714E	150	5.7	1.93	5.37	10.71	20.72	26.51	80.69	100.00	1.21	26.51	54.18	19.31
714E	155	4.9	2.52	6.63	13.32	24.16	29.23	84.47	100.00	0.37	29.23	55.25	15.53
714E	160	6.0	2.22	6.34	12.82	24.73	29.71	83.14	100.00	0.53	29.71	53.43	16.86
714E	165	5.1	1.70	5.92	15.43	27.26	32.36	81.87	100.00	0.01	32.36	49.51	18.13
714E	170	2.8	2.03	5.37	13.56	24.93	29.84	81.53	100.00	0.21	29.84	51.68	18.47
714E	175	3.9	1.81	5.65	15.33	27.77	33.00	83.92	100.00	0.65	33.00	50.92	16.08
714E	180	4.3	3.88	8.44	17.44	29.44	33.69	85.40	100.00	9.00	33.69	51.71	14.60
714E	185	3.9	4.35	6.05	13.09	23.19	28.44	88.94	100.00	0.81	28.44	60.50	11.06
714E	190	3.7	2.40	6.59	13.70	23.72	29.01	90.42	100.00	1.00	29.01	61.41	9.58
714E	195	3.9	2.73	7.25	15.32	25.90	31.05	88.82	100.00	2.89	31.05	57.77	11.18
714E	200	2.8	1.21	5.49	13.11	23.56	29.35	89.37	100.00	0.75	29.35	60.02	10.63
715E	10	6.1	1.79	5.81	13.41	26.81	32.63	83.64	100.00	0.10	32.63	51.01	16.36
715E	20	7.0	3.68	10.30	20.69	37.39	44.32	88.92	100.00	2.53	44.32	44.60	11.08
715E	30	5.9	3.57	10.13	18.67	33.98	40.34	87.99	100.00	1.62	40.34	47.64	12.01
715E	40	7.2	3.93	10.65	20.69	37.15	43.41	90.35	100.00	2.73	43.41	46.94	9.65
716E	10	7.9	2.14	6.97	16.30	31.65	38.11	83.43	100.00	0.68	38.11	45.32	16.57
716E	20	5.2	2.34	6.12	13.80	25.04	31.11	87.24	100.00	4.80	31.11	56.13	12.76
716E	30	6.5	3.64	6.52	12.63	24.77	31.04	85.76	100.00	0.39	31.04	54.72	14.24
716E	40	7.5	3.37	10.03	21.92	36.13	42.24	90.23	100.00	0.60	42.24	47.99	9.77

Hole/Depth		CaCO3	- - - - - - - - - Cumulative - Percentages - - - - - - - - -									
		Equiv.	- - - - Sand (Sieve intervals) - - - - - -					%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
			10-20	10-40	10-60	10-140	10-230						
716E	50	7.4	3.33	9.89	22.43	36.30	42.34	91.56	100.00	1.49	42.34	49.22	8.44
716E	60	6.6	3.63	9.89	19.46	34.46	40.52	90.50	100.00	2.12	40.52	49.99	9.50
716E	70	7.4	3.36	11.58	23.06	36.86	42.81	92.49	100.00	1.59	42.81	49.68	7.51
716E	80	6.5	3.67	9.80	19.36	34.28	40.00	85.25	100.00	1.84	40.00	45.26	14.75
716E	90	6.6	3.73	10.05	19.95	33.74	39.79	88.09	100.00	1.10	39.79	48.29	11.91
716E	100	7.7	4.11	11.56	22.06	38.73	45.59	89.17	100.00	2.58	45.59	43.58	10.83
716E	110	7.7	1.78	5.84	18.33	41.53	48.08	88.41	100.00	0.92	48.08	40.32	11.59
716E	120	5.2	2.97	8.15	14.96	26.19	30.86	83.08	100.00	2.34	30.86	52.22	16.92
716E	130	2.6	0.79	2.55	4.61	7.58	9.62	69.28	100.00	0.40	9.62	59.66	30.72
716E	140	4.8	3.03	8.42	15.99	29.11	35.30	90.67	100.00	0.30	35.30	55.38	9.33
716E	150	5.5	3.76	10.39	19.49	32.26	38.13	89.11	100.00	5.54	38.13	50.97	10.89
716E	160	7.3	3.69	10.26	21.03	35.36	41.61	87.52	100.00	3.09	41.61	45.91	12.48
716E	170	5.8	5.24	13.51	22.35	38.67	44.89	87.97	100.00	2.52	44.89	43.09	12.03
716E	180	6.6	4.27	11.69	21.57	38.77	45.73	89.58	100.00	3.80	45.73	43.84	10.42
716E	190	5.8	3.36	9.38	17.94	32.24	36.95	85.59	100.00	0.69	36.95	48.64	14.41
716E	200	6.2	3.27	9.22	17.31	32.90	38.55	82.32	100.00	1.62	38.55	43.77	17.68
716E	210	10.6	3.81	9.86	18.17	32.46	38.40	89.71	100.00	4.21	38.40	51.31	10.29
716E	220	9.4	2.90	8.01	15.40	28.82	34.32	85.51	100.00	3.05	34.32	51.18	14.49
716E	230	8.1	3.21	9.73	22.18	37.82	43.30	85.10	100.00	0.68	43.30	41.80	14.90
716E	240	2.7	2.96	9.26	19.39	31.25	35.61	83.91	100.00	0.88	35.61	48.30	16.09
716E	250	3.7	3.59	9.78	22.02	33.00	38.50	88.89	100.00	0.50	38.50	50.39	11.11
716E	260	4.4	4.65	12.11	21.32	35.16	38.82	90.19	100.00	0.90	38.82	51.37	9.81
716E	270	3.9	4.30	10.71	21.17	34.03	39.65	91.36	100.00	0.85	39.65	51.71	8.64
716E	280	4.6	4.29	11.96	22.02	36.61	43.05	89.81	100.00	2.11	43.05	46.75	10.19
716E	290	4.4	4.63	11.51	20.94	34.42	40.08	88.79	100.00	3.25	40.08	48.71	11.21

Hole/Depth		CaCO3 Equiv.	Cumulative - Percentages Sand (Sieve intervals) 10-20	10-40	10-60	10-140	10-230	%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
716E	310	7.4	0.59	3.62	8.46	13.38	16.18	83.91	100.00	0.80	16.18	67.73	16.09
716E	349	4.0	3.12	9.53	21.94	35.71	42.22	86.04	100.00	0.72	42.22	43.82	13.96
716E	360	4.3	2.73	8.09	18.74	33.34	40.41	91.48	100.00	1.00	40.41	51.07	8.52
717E	15	4.8	5.86	14.00	22.85	38.80	46.27	87.42	100.00	4.01	46.27	41.15	12.58
717E	20	7.4	8.47	19.55	31.82	47.66	52.99	90.26	100.00	6.80	52.99	37.27	9.74
717E	25	8.2	5.61	13.00	23.36	39.27	46.28	90.33	100.00	10.00	46.28	44.04	9.67
717E	30	7.3	4.45	11.30	21.75	35.75	41.91	92.85	100.00	3.63	41.91	50.94	7.15
717E	35	9.3	3.93	10.87	21.01	37.59	44.35	95.09	100.00	3.54	44.35	50.74	4.91
717E	40	7.0	4.73	12.45	23.01	38.44	45.27	91.15	100.00	3.90	45.27	45.88	8.85
717E	60	7.9	4.44	13.04	24.85	43.34	50.99	95.54	100.00	2.95	50.99	44.55	4.46
717E	120	4.7	3.01	7.98	15.43	27.60	34.19	89.81	100.00	0.77	34.19	55.62	10.19
717E	130	4.2	4.12	9.50	16.16	28.88	34.46	88.18	100.00	10.10	34.46	53.73	11.82
717E	140	5.7	1.82	5.81	12.40	23.74	29.94	90.02	100.00	0.61	29.94	60.07	9.98
717E	150	5.4	1.25	10.65	18.58	30.41	36.96	90.56	100.00	1.89	36.96	53.60	9.44
717E	160	7.7	0.50	1.74	3.75	7.34	9.36	79.64	100.00	0.0	9.36	70.28	20.36
717E	170	4.6	1.81	6.52	14.75	29.47	38.10	88.52	100.00	1.00	38.10	50.42	11.48
717E	210	4.5	2.33	5.72	12.01	21.49	27.64	86.88	100.00	2.69	27.64	59.24	13.12
718E	10	2.7	0.99	3.61	9.14	19.57	25.95	82.57	100.00	0.22	25.95	56.62	17.43
718E	20	4.0	3.09	9.52	20.50	34.57	41.39	92.61	100.00	0.94	41.39	51.22	7.39
718E	30	1.1	0.0	0.67	2.31	7.46	23.88	87.05	100.00	0.0	23.88	63.17	12.95
718E	40	7.9	1.85	5.63	11.04	21.64	28.68	87.96	100.00	1.03	28.68	59.28	12.04
718E	50	4.1	1.98	5.23	14.15	27.14	34.40	88.43	100.00	2.00	34.40	54.03	11.57
718E	60	4.3	2.55	7.81	16.53	29.72	36.41	90.35	100.00	1.34	36.41	53.94	9.65

Hole/Depth		CaCO3	- - - - - - - - - - Cumulative	- Percentages	- - - -	- - - -	- - - -	- - - -	- - - -				
		Equiv.	- - - - Sand (Sieve intervals)	- - - -	- - - -	- - - -	- - - -	%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
			10-20	10-40	10-60	10-140	10-230						
718E	70	3.8	2.69	7.89	16.61	30.11	36.76	91.13	100.00	0.85	36.76	54.38	8.87
718E	80	4.3	4.27	10.79	19.27	32.79	40.08	84.77	100.00	0.65	40.08	44.69	15.23
718E	90	4.0	2.92	8.43	18.44	31.88	37.93	91.49	100.00	1.12	37.93	53.56	8.51
718E	100	3.8	1.85	6.26	13.43	26.24	31.42	91.58	100.00	0.57	31.42	60.16	8.42
718E	110	3.2	2.62	8.71	20.56	35.24	42.48	91.72	100.00	0.77	42.48	49.24	8.28
718E	120	3.6	2.76	8.46	17.78	32.89	39.79	92.23	100.00	1.71	39.79	52.45	7.77
718E	130	2.9	2.89	9.39	19.91	35.55	42.28	91.63	100.00	1.42	42.28	49.35	8.37
718E	140	2.5	2.61	8.43	19.32	35.23	42.63	88.43	100.00	0.78	42.63	45.80	11.57
718E	150	3.1	1.30	4.26	10.07	19.22	24.24	84.28	100.00	0.13	24.24	60.04	15.72
718E	160	4.4	2.08	6.05	12.68	25.08	32.40	87.19	100.00	0.81	32.40	54.78	12.81
718E	170	3.9	3.87	6.16	12.26	25.47	32.04	83.94	100.00	1.70	32.04	51.90	16.06
718E	180	4.7	2.00	6.28	14.52	29.23	37.97	84.34	100.00	1.99	37.97	46.37	15.66
718E	190	4.4	2.72	8.88	20.39	34.76	40.39	87.09	100.00	3.20	40.39	46.71	12.91
718E	200	4.7	2.86	8.97	17.84	31.85	37.13	90.55	100.00	0.60	37.13	53.43	9.45
718E	210	4.8	3.20	8.45	18.64	33.35	38.44	89.13	100.00	7.21	38.44	50.69	10.87
719E	10	6.3	2.15	7.00	14.83	28.88	35.46	81.36	100.00	0.88	35.46	45.89	18.64
719E	20	5.8	3.62	9.60	18.60	33.44	39.45	82.86	100.00	4.25	39.45	43.41	17.14
719E	30	7.2	3.54	9.82	19.79	34.58	40.64	90.34	100.00	1.49	40.64	49.71	9.66
719E	40	8.6	4.82	12.14	22.74	38.58	45.36	89.01	100.00	8.75	45.36	43.65	10.99
719E	50	8.8	3.89	11.17	22.36	39.13	46.59	88.32	100.00	2.02	46.59	41.73	11.68
719E	60	3.2	3.94	11.40	22.44	38.16	44.84	86.39	100.00	2.01	44.84	41.55	13.61
719E	70	3.3	2.48	7.41	15.95	27.67	34.55	82.73	100.00	2.42	34.55	48.18	17.27
719E	80	3.6	2.91	8.68	17.78	30.54	36.67	91.17	100.00	1.40	36.67	54.49	8.83
719E	90	4.6	5.35	14.29	25.53	41.98	48.95	93.89	100.00	2.63	48.95	44.95	6.11

Hole/Depth		CaCO3	Cumulative - Percentages										
		Equiv.	Sand (Sieve intervals)					%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
			10-20	10-40	10-60	10-140	10-230						
719E	100	4.3	3.75	11.38	28.53	38.53	44.62	92.06	100.00	0.98	44.62	47.43	7.94
719E	110	3.9	2.28	6.58	12.42	21.71	28.35	90.40	100.00	2.00	28.35	62.05	9.60
723E	5	2.1	0.0	0.35	1.83	4.21	4.98	79.24	100.00	0.31	4.98	74.26	20.76
723E	10	4.0	2.26	7.82	17.45	31.91	38.46	87.73	100.00	1.60	38.46	49.26	12.27
723E	15	4.4	2.95	8.90	17.25	31.68	37.86	89.16	100.00	9.38	37.86	51.30	10.84
723E	20	5.5	2.59	8.68	17.42	32.58	39.72	87.34	100.00	0.40	39.72	47.63	12.66
723E	25	4.6	1.96	7.35	17.11	33.39	41.54	87.84	100.00	0.80	41.54	46.30	12.16
723E	30	4.6	2.70	8.35	16.96	32.53	39.68	85.52	100.00	1.43	39.68	45.84	14.48
723E	35	5.0	2.77	8.42	17.74	31.80	39.16	88.73	100.00	2.70	39.16	49.58	11.27
723E	40	5.1	2.67	8.16	17.64	32.82	40.99	86.22	100.00	7.00	40.99	45.23	13.78
723E	45	4.0	2.98	8.56	16.88	32.24	39.82	86.70	100.00	2.21	39.82	46.88	13.30
723E	50	5.2	2.00	5.89	12.72	23.43	28.66	84.24	100.00	2.60	28.66	55.58	15.76
723E	55	4.7	2.48	7.98	16.35	32.27	40.45	87.29	100.00	2.45	40.45	46.84	12.71
723E	60	5.5	2.64	7.70	16.98	34.02	41.89	88.41	100.00	3.50	41.89	46.52	11.59
723E	65	5.2	2.60	6.86	15.58	31.13	38.59	87.47	100.00	2.55	38.59	48.88	12.53
723E	70	4.7	3.02	8.64	17.79	34.43	41.62	87.76	100.00	2.30	41.62	46.14	12.24
723E	75	4.8	2.58	7.22	14.17	25.66	30.35	81.22	100.00	5.90	30.35	50.87	18.78
723E	80	4.0	2.58	7.13	16.10	28.28	34.92	85.28	100.00	0.71	34.92	50.36	14.72
723E	85	5.9	3.73	8.68	16.44	28.09	33.91	84.09	100.00	3.20	33.91	50.19	15.91
723E	90	4.8	1.99	7.70	17.29	28.32	34.60	84.89	100.00	2.25	34.60	50.29	15.11
723E	100	4.8	4.47	17.35	24.05	39.69	47.08	84.99	100.00	1.01	47.08	37.91	15.01
723E	105	6.0	1.53	5.63	12.25	23.34	28.27	76.70	100.00	0.51	28.27	48.44	23.30

Hole/Depth		CaCO3 Equiv.	Cumulative - Percentages										
			Sand (Sieve intervals)					%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
			10-20	10-40	10-60	10-140	10-230						
725E	10	5.4	2.10	6.79	13.82	25.63	31.22	88.58	100.00	1.09	31.22	57.36	11.42
725E	15	7.4	1.92	5.45	14.29	29.82	37.53	91.94	100.00	0.75	37.53	54.40	8.06
725E	20	7.0	3.16	7.86	13.43	23.73	28.56	84.21	100.00	6.51	28.56	55.64	15.79
725E	25	7.0	2.04	6.18	12.80	24.62	30.43	84.24	100.00	1.81	30.43	53.82	15.76
725E	30	6.6	4.47	9.49	16.53	28.34	33.92	86.10	100.00	2.09	33.92	52.19	13.90
725E	35	7.4	1.90	5.59	10.86	23.05	30.53	81.70	100.00	0.50	30.53	51.16	18.30
725E	40	7.5	2.77	7.72	14.25	27.44	34.18	84.33	100.00	2.00	34.18	50.16	15.67
725E	45	9.1	2.23	5.14	9.47	18.80	23.09	85.82	100.00	1.31	23.09	62.73	14.18
725E	60	7.3	1.70	6.48	15.92	35.84	44.19	85.86	100.00	0.61	44.19	41.67	14.14
725E	65	6.7	2.79	6.87	11.88	24.13	29.71	88.29	100.00	1.51	29.71	58.58	11.71
725E	70	5.1	1.76	5.31	11.05	20.30	24.05	88.47	100.00	0.91	24.05	64.42	11.53
725E	75	8.1	2.55	7.07	13.54	26.94	32.67	83.17	100.00	1.00	32.67	50.50	16.83
725E	80	6.3	1.43	4.13	8.08	18.31	23.41	82.81	100.00	0.31	23.41	59.40	17.19
725E	85	6.1	1.52	4.73	9.09	18.23	23.05	76.03	100.00	0.45	23.05	52.98	23.97
725E	90	4.8	1.37	4.38	8.52	15.70	19.71	86.31	100.00	1.32	19.71	66.61	13.69
725E	95	7.3	12.92	19.81	29.41	46.58	51.96	84.14	100.00	0.75	51.96	32.18	15.86
725E	100	7.5	2.24	8.61	18.28	33.42	38.91	91.84	100.00	1.05	38.91	52.93	8.16
725E	105	6.8	3.72	9.30	19.05	32.89	37.81	89.04	100.00	16.18	37.81	51.23	10.96
725E	108	6.4	9.38	17.26	25.20	49.76	55.33	84.13	100.00	15.62	55.33	28.80	15.87
725E	115	6.8	2.08	5.86	11.90	21.91	25.64	83.56	100.00	0.65	25.64	57.92	16.44
725E	120	5.5	2.24	5.77	11.97	23.09	27.91	83.69	100.00	2.14	27.91	55.78	16.31
725E	125	7.8	2.23	5.55	11.24	21.50	25.58	85.44	100.00	0.36	25.58	59.85	14.56
725E	130	6.3	2.37	6.24	12.14	22.82	28.04	86.28	100.00	2.35	28.04	58.24	13.72
725E	136	7.0	4.87	11.60	21.62	34.79	40.39	78.18	100.00	1.48	40.39	37.79	21.82
725E	140	8.3	5.67	12.95	22.14	37.40	43.27	86.66	100.00	1.00	43.27	43.39	13.34

Hole/Depth		CaCO3	Cumulative - Percentages										
		Equiv.	Sand (Sieve intervals)					%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
			10-20	10-40	10-60	10-140	10-230						
725E	145	4.7	1.29	3.96	9.17	17.95	21.58	80.58	100.00	0.95	21.58	59.00	19.42
725E	150	7.7	2.85	8.03	15.98	29.03	34.38	84.61	100.00	2.80	34.38	50.23	15.39
725E	155	7.0	4.14	8.96	16.55	29.38	35.17	83.79	100.00	4.31	35.17	48.62	16.21
725E	160	7.8	1.76	5.32	11.79	23.00	28.79	85.51	100.00	0.59	28.79	56.72	14.49
725E	165	6.5	4.21	9.84	16.38	30.85	39.06	85.41	100.00	3.95	39.06	46.35	14.59
725E	170	8.5	2.09	6.30	12.63	27.01	34.66	85.73	100.00	0.42	34.66	51.08	14.27
725E	175	6.6	2.12	5.32	10.54	20.31	25.44	87.13	100.00	0.69	25.44	61.68	12.87
725E	180	5.7	0.74	1.81	3.75	7.29	10.05	81.92	100.00	0.13	10.05	71.86	18.08
725E	190	6.3	5.20	10.49	17.91	29.69	35.65	85.34	100.00	14.30	35.65	49.69	14.66
725E	195	8.4	2.67	7.45	13.76	26.39	32.19	88.64	100.00	0.63	32.19	56.45	11.36
725E	200	6.5	2.28	6.54	12.47	24.68	30.59	88.60	100.00	5.59	30.59	58.01	11.40
725E	210	8.8	1.94	7.69	15.53	28.68	35.20	84.75	100.00	5.30	35.20	49.54	15.25
725E	220	7.2	2.20	6.70	14.33	27.33	32.98	87.54	100.00	1.80	32.98	54.56	12.46
725E	230	6.9	2.09	5.79	12.38	23.58	29.29	87.17	100.00	1.19	29.29	57.88	12.83
725E	240	7.0	0.77	2.92	8.77	21.60	27.76	83.51	100.00	0.59	27.76	55.75	16.49
725E	250	7.3	1.86	5.02	11.13	22.17	26.50	87.11	100.00	1.32	26.50	60.60	12.89
725E	255	7.2	2.15	6.29	13.81	26.26	32.77	84.99	100.00	1.42	32.77	52.22	15.01
726E	10	5.8	1.17	3.43	7.76	15.52	19.88	79.90	100.00	0.31	19.88	60.03	20.10
726E	20	7.3	1.45	4.25	9.02	17.98	22.62	82.76	100.00	5.61	22.62	60.14	17.24
726E	30	4.7	2.29	5.98	11.52	21.45	26.46	81.29	100.00	0.41	26.46	54.83	18.71
726E	40	6.5	1.84	5.82	11.75	23.11	28.90	83.57	100.00	0.30	28.90	54.67	16.43
726E	50	5.4	8.07	15.92	21.53	33.31	38.46	75.96	100.00	3.10	38.46	37.50	24.04
726E	55	5.1	2.08	6.66	14.62	26.04	31.48	86.79	100.00	1.10	31.48	55.31	13.21
726E	60	5.1	2.48	7.58	15.77	28.30	33.42	84.04	100.00	1.39	33.42	50.62	15.96

Hole/Depth		CaCO3 Equiv.	Cumulative - Percentages: Sand (Sieve intervals) 10-20	10-40	10-60	10-140	10-230	%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
726E	70	4.3	3.82	9.48	16.29	29.04	37.86	87.15	100.00	4.61	37.86	49.29	12.85
726E	80	5.1	2.45	7.19	12.38	23.52	28.92	91.04	100.00	0.80	28.92	62.12	8.96
726E	90	4.2	1.84	6.29	11.63	26.30	33.16	90.38	100.00	0.60	33.16	57.22	9.62
726E	100	3.2	3.93	10.27	17.92	29.90	35.50	89.71	100.00	6.95	35.50	54.21	10.29
726E	120	4.0	1.98	6.43	11.74	23.30	29.53	89.01	100.00	0.19	29.53	59.48	10.99
726E	140	3.8	2.56	8.28	15.19	29.26	35.54	91.01	100.00	0.89	35.54	55.47	8.99
726E	150	4.2	3.09	8.87	16.82	32.28	38.86	90.40	100.00	1.91	38.86	51.54	9.60
726E	160	3.2	2.98	8.79	12.46	19.21	22.54	91.84	100.00	1.00	22.54	69.30	8.16
726E	170	2.5	2.05	6.96	14.99	27.57	33.76	89.90	100.00	0.90	33.76	56.14	10.10
726E	180	3.1	1.63	6.54	14.70	29.48	35.75	88.49	100.00	1.04	35.75	52.74	11.51
726E	190	5.5	6.86	13.13	20.33	34.51	39.88	87.07	100.00	2.11	39.88	47.19	12.93
728E	20	5.7	0.16	0.80	10.40	27.73	35.09	96.16	100.00	0.0	35.09	61.08	3.84
728E	30	8.6	2.88	8.49	8.93	10.12	14.23	72.15	100.00	0.50	14.23	57.92	27.85
728E	40	5.2	3.08	8.20	20.98	39.97	47.34	83.78	100.00	3.31	47.34	36.44	16.22
728E	50	8.2	3.66	11.51	17.25	29.12	33.86	89.30	100.00	0.82	33.86	55.44	10.70
728E	60	3.9	2.76	8.55	17.45	33.49	41.13	91.64	100.00	1.00	41.13	50.51	8.36
728E	70	5.1	3.95	9.82	18.04	32.53	38.80	90.16	100.00	5.14	38.80	51.36	9.83
728E	80	4.1	3.23	9.04	18.20	32.57	39.40	88.68	100.00	5.10	39.40	49.29	11.32
728E	88	3.8	2.36	7.74	16.18	31.76	38.67	90.30	100.00	0.49	38.67	51.63	9.70
729E	10	5.7	1.89	6.24	14.81	29.90	48.00	91.25	100.00	0.50	48.00	43.26	8.75
729E	20	5.2	5.37	15.88	23.69	36.20	41.33	84.55	100.00	2.00	41.33	43.22	15.45
729E	30	6.8	1.19	4.69	18.35	39.80	47.41	95.05	100.00	0.69	47.41	47.64	4.95

Hole/Depth		CaCO3	- - - - - - - - - Cumulative - Percentages										
		Equiv.	- - - - Sand (Sieve intervals) - - - - - -					%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
			10-20	10-40	10-60	10-140	10-230						
756E	5	7.3	3.38	9.23	18.50	36.31	41.74	84.62	100.00	1.90	41.74	42.87	15.38
756E	15	10.5	3.58	11.01	24.33	51.21	56.12	90.01	100.00	1.38	56.12	33.90	9.99
756E	29	8.0	4.14	11.14	24.39	41.82	47.51	87.56	100.00	2.24	47.51	40.05	12.44
756E	40	7.1	6.78	11.79	24.14	41.12	46.61	88.65	100.00	1.89	46.61	42.03	11.35
756E	50	7.6	4.41	12.26	25.27	44.92	50.73	90.45	100.00	4.47	50.73	39.72	9.55
756E	60	7.2	4.47	11.26	22.87	40.98	46.37	87.03	100.00	4.00	46.37	40.66	12.97
756E	70	7.7	2.39	11.95	23.65	41.37	47.24	91.41	100.00	1.70	47.24	44.17	8.59
756E	75	6.3	4.66	12.01	23.54	42.77	46.44	88.27	100.00	5.42	46.44	41.83	11.73
756E	80	7.6	4.17	11.13	20.69	41.97	46.64	92.48	100.00	2.70	46.64	45.84	7.52
756E	90	7.2	9.17	14.29	27.50	46.94	52.48	90.50	100.00	4.17	52.48	38.01	9.50
756E	100	7.8	4.35	11.71	21.95	42.75	50.51	92.13	100.00	3.50	50.51	41.62	7.87
756E	105	6.4	6.00	15.12	26.47	48.28	52.88	88.48	100.00	3.00	52.88	35.60	11.52
756E	110	7.0	4.83	12.17	22.00	41.50	46.68	92.44	100.00	5.33	46.68	45.75	7.56
756E	120	10.1	3.26	3.42	12.32	30.06	35.90	88.28	100.00	2.40	35.90	52.38	11.72
756E	130	9.0	3.42	8.62	18.63	33.66	38.58	91.80	100.00	2.60	38.58	53.22	8.20
756E	135	7.8	3.64	9.03	17.18	31.78	36.84	85.66	100.00	4.60	36.84	48.82	14.34
757E	10	5.9	3.50	10.79	20.68	38.05	44.93	81.47	100.00	0.01	44.93	36.54	18.53
757E	20	5.1	7.16	16.61	27.23	47.29	54.12	92.20	100.00	2.14	54.12	38.09	7.80
757E	30	6.5	4.39	11.35	22.73	40.74	47.64	90.61	100.00	5.29	47.64	42.97	9.39
757E	40	7.0	4.32	11.66	22.47	40.68	47.35	90.69	100.00	1.71	47.35	43.34	9.31
757E	48	6.9	5.95	14.61	26.14	44.27	50.61	91.79	100.00	10.07	50.61	41.18	8.21
757E	50	7.7	4.58	12.35	23.30	40.96	47.87	89.64	100.00	4.08	47.87	41.78	10.36
757E	60	7.2	6.22	14.32	25.05	41.56	47.88	86.43	100.00	1.28	47.88	38.55	13.57
757E	70	7.2	3.72	10.63	21.39	38.57	45.42	89.29	100.00	2.60	45.42	43.87	10.71

Hole/Depth	CaCO3	- - - - - - - - - - Cumulative - Percentages - - - - - - - - - -										
	Equiv.	- - - - Sand (Sieve intervals) - - - - - -					%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
		10-20	10-40	10-60	10-140	10-230						
757E 80	6.3	6.53	13.99	25.23	42.60	48.68	84.89	100.00	4.30	48.68	36.21	15.11
757E 90	6.5	5.29	12.90	23.43	40.91	47.26	89.34	100.00	3.38	47.26	42.07	10.66
757E 100	6.9	5.13	12.60	23.37	40.84	47.59	84.68	100.00	3.60	47.59	37.08	15.32
757E 108	7.2	6.32	14.17	24.82	41.84	48.65	84.93	100.00	5.00	48.65	36.28	15.07
757E 320	5.4	1.14	3.99	9.01	16.25	19.88	91.44	100.00	0.10	19.88	71.56	8.56
758E 60	6.5	3.65	8.78	16.38	28.67	34.22	89.22	100.00	11.62	34.22	55.01	10.78
758E 68	7.0	3.29	9.86	21.48	38.70	45.26	88.61	100.00	0.10	45.26	43.34	11.39
758E 90	7.3	3.08	9.87	21.34	39.04	45.61	89.63	100.00	1.45	45.61	44.01	10.37
758E 120	3.5	3.22	9.28	19.02	34.02	40.77	93.03	100.00	1.09	40.77	52.26	6.97
758E 150	3.3	1.59	7.72	16.53	11.57	36.97	88.67	100.00	0.59	36.97	51.70	11.33
758E 180	2.6	0.93	6.23	13.55	26.14	33.07	86.59	100.00	0.81	33.07	53.52	13.41
758E 210	2.9	2.29	7.63	15.83	28.91	35.46	88.23	100.00	1.31	35.46	52.77	11.77
758E 240	3.0	1.57	6.67	14.88	29.58	36.71	80.38	100.00	0.10	36.71	43.66	19.62
758E 270	2.7	1.92	6.84	13.42	25.11	31.09	88.93	100.00	0.40	31.09	57.83	11.07
758E 300	3.0	2.64	7.50	15.88	30.30	36.65	94.61	100.00	2.33	36.65	57.96	5.39
758E 330	5.2	1.58	4.53	9.49	18.01	22.26	85.15	100.00	0.20	22.26	62.89	14.85
759E 20	4.1	4.81	10.97	20.23	36.06	41.45	85.95	100.00	4.03	41.45	44.51	14.05
759E 30	3.9	2.39	7.71	16.34	32.21	38.46	89.25	100.00	0.74	38.46	50.79	10.75
759E 43	3.8	3.23	8.61	14.49	36.71	46.80	98.20	100.00	1.99	46.80	51.41	1.80
759E 50	4.4	2.23	7.24	14.58	29.65	36.14	87.30	100.00	1.80	36.14	51.17	12.70
760E 10	9.7	3.61	9.41	20.03	35.58	39.85	84.51	100.00	4.34	39.85	44.66	15.49
760E 20	9.6	5.29	12.87	22.68	44.67	49.94	88.40	100.00	2.80	49.94	38.47	11.60

Hole/Depth	CaCO3	Cumulative - Percentages										
	Equiv.	Sand (Sieve intervals)					%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
		10-20	10-40	10-60	10-140	10-230						
760E 30	9.8	4.77	11.64	21.66	42.41	47.79	88.87	100.00	2.20	47.79	41.09	11.13
760E 40	11.3	5.36	13.01	23.51	43.66	50.45	90.47	100.00	4.48	50.45	40.02	9.53
760E 50	9.5	5.13	12.59	24.89	42.57	49.23	89.66	100.00	3.80	49.23	40.42	10.34
760E 60	8.6	5.58	13.15	27.78	43.26	50.25	92.58	100.00	2.54	50.25	42.34	7.42
760E 65	10.3	4.93	12.88	23.15	42.83	48.68	93.90	100.00	3.20	48.68	45.21	6.10
760E 70	10.5	5.54	13.22	22.07	40.79	48.45	94.25	100.00	6.20	48.45	45.80	5.75
760E 75	5.5	3.32	8.87	18.53	34.57	40.15	86.47	100.00	1.06	40.15	46.31	13.53
760E 80	10.7	5.78	13.60	23.55	42.12	49.77	93.42	100.00	3.26	49.77	43.65	6.58
760E 90	8.2	4.61	13.30	27.95	51.22	59.32	93.75	100.00	1.60	59.32	34.43	6.25
760E 100	8.1	4.74	12.11	22.52	41.93	47.07	92.27	100.00	2.17	47.07	45.19	7.73
760E 110	8.3	4.03	12.81	25.15	47.41	54.11	91.54	100.00	1.68	54.11	37.44	8.46
760E 120	9.9	4.27	14.13	25.97	53.36	64.19	92.47	100.00	1.70	64.19	28.28	7.53
761E 20	7.8	3.52	9.00	17.32	33.57	40.44	84.73	100.00	7.11	40.44	44.30	15.27
761E 25	6.6	3.12	7.06	12.84	25.04	31.86	83.54	100.00	10.34	31.86	51.68	16.46
761E 40	11.0	4.82	11.30	20.72	40.01	47.93	88.35	100.00	4.40	47.93	40.42	11.65
761E 50	9.9	5.20	13.04	23.98	43.31	51.15	90.06	100.00	4.55	51.15	38.91	9.94
761E 60	11.2	5.00	12.99	23.96	42.02	51.21	90.40	100.00	2.72	51.21	39.19	9.60
761E 70	9.8	2.89	7.88	14.42	15.40	15.74	85.69	100.00	1.71	15.74	69.96	14.31
761E 75	10.4	5.45	14.41	20.62	21.06	21.67	85.38	100.00	0.92	21.67	63.70	14.62
761E 80	9.1	3.90	10.32	17.46	17.82	18.47	91.88	100.00	1.22	18.47	73.41	8.12
761E 90	9.8	2.42	6.20	11.14	23.16	30.86	83.10	100.00	0.20	30.86	52.24	16.90
761E 100	11.9	5.70	12.34	19.67	20.04	20.77	90.91	100.00	12.20	20.77	70.13	9.09
761E 105	9.3	5.89	13.86	24.24	44.66	51.89	92.40	100.00	1.18	51.89	40.51	7.60
761E 115	8.8	4.52	12.53	22.76	42.20	48.15	91.60	100.00	1.10	48.15	43.45	8.40

Hole/Depth		CaCO3	- - - - - - - - - Cumulative - Percentages - - - - - - - - -										
		Equiv.	- - - - Sand (Sieve intervals) - - - - - -					%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
			10-20	10-40	10-60	10-140	10-230						
761E	125	10.1	3.61	10.61	19.90	20.60	20.90	94.38	100.00	2.10	20.90	73.48	5.62
761E	135	11.5	3.74	7.48	22.96	27.74	27.97	95.29	100.00	6.70	27.97	67.32	4.71
761E	150	10.0	5.06	11.97	20.66	21.48	21.75	91.38	100.00	1.03	21.75	69.63	8.62
762E	20	10.2	0.0	0.0	5.68	5.80	6.48	81.94	100.00	0.0	6.48	75.46	18.06
762E	240	8.3	1.80	4.50	9.64	24.32	32.63	80.68	100.00	1.03	32.63	48.05	19.32
762E	245	9.2	2.58	6.53	13.87	25.58	30.89	96.94	100.00	0.55	30.89	66.05	3.06
763E	40	16.6	2.49	8.54	12.41	22.37	27.72	92.82	100.00	0.63	27.72	65.10	7.18
763E	50	16.4	2.75	9.82	16.77	36.18	42.89	89.65	100.00	4.19	42.89	46.76	10.35
763E	60	9.7	4.92	13.11	24.44	45.20	53.78	93.68	100.00	2.72	53.78	39.90	6.32
763E	75	9.6	5.43	15.62	28.43	47.75	55.17	90.51	100.00	2.13	55.17	35.33	9.49
763E	80	8.7	4.17	10.78	18.03	40.67	49.28	94.16	100.00	1.62	49.28	44.87	5.84
763E	90	9.8	4.30	12.20	21.82	42.28	50.26	93.76	100.00	2.99	50.26	43.50	6.24
763E	100	9.2	5.00	13.35	25.92	49.32	58.17	94.94	100.00	4.01	58.17	36.77	5.06
763E	110	8.8	4.19	13.68	26.52	51.75	59.58	94.07	100.00	1.83	59.58	34.49	5.93
764E	5	8.4	2.98	10.15	19.53	35.04	42.34	83.50	100.00	0.89	42.34	41.15	16.50
764E	45	10.8	4.62	12.29	22.19	42.11	49.32	86.43	100.00	3.95	49.32	37.11	13.57
764E	55	11.2	4.80	12.58	25.70	41.41	49.36	92.97	100.00	7.92	49.36	43.61	7.03
764E	65	10.6	4.95	15.64	32.09	56.55	64.69	94.17	100.00	2.35	64.69	29.49	5.83
764E	90	13.0	4.00	8.84	24.86	46.45	54.55	92.30	100.00	8.89	54.55	37.75	7.70
764E	98	12.8	4.21	11.06	19.94	39.37	44.23	89.92	100.00	2.50	44.23	45.69	10.08
764E	111	13.9	4.66	13.16	25.16	48.61	53.83	91.01	100.00	6.98	53.83	37.18	8.99
764E	120	12.5	4.77	13.10	23.93	39.30	43.86	90.18	100.00	7.52	43.86	46.33	9.82

Hole/Depth		CaCO3	- - - - - - - - - Cumulative - Percentages - - - - - - - - -									
		Equiv.	- - - - Sand (Sieve intervals) - - - - - -					%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
			10-20	10-40	10-60	10-140	10-230						
764E	125	11.9	4.48	12.07	21.43	42.20	47.73	94.05	100.00	2.79	47.73	46.32	5.95
764E	135	9.3	4.39	11.73	21.40	37.39	44.51	88.79	100.00	7.65	44.51	44.28	11.21
764E	144	9.7	3.65	10.26	21.42	39.11	43.71	92.17	100.00	8.19	43.71	48.46	7.83
764E	155	13.7	4.44	10.85	18.54	31.78	38.04	94.30	100.00	1.90	38.04	56.26	5.70
765E	30	7.9	2.51	8.09	15.61	31.29	36.60	83.50	100.00	0.60	36.60	46.90	16.50
765E	50	9.1	2.22	5.63	11.29	25.63	32.35	82.43	100.00	2.90	32.35	50.08	17.57
765E	70	7.0	2.74	5.19	9.09	16.54	19.72	70.64	100.00	1.00	19.72	50.92	29.36
765E	90	10.6	5.05	13.63	24.28	42.22	51.00	93.46	100.00	2.52	51.00	42.45	6.54
765E	110	10.4	5.62	14.25	25.77	44.75	53.97	93.64	100.00	4.50	53.97	39.67	6.36
765E	297	4.6	4.36	12.48	22.28	37.61	46.16	92.51	100.00	2.70	46.16	46.35	7.49
765E	300	7.9	5.05	12.93	22.57	41.30	48.68	94.08	100.00	2.20	48.68	45.40	5.92
795E	20	7.3	4.31	11.83	21.50	41.65	49.92	89.22	100.00	2.58	49.92	39.30	10.78
795E	25	6.1	3.28	10.31	21.71	43.06	50.43	86.86	100.00	2.40	50.43	36.43	13.14
795E	50	7.7	2.69	9.04	18.04	37.93	47.18	89.90	100.00	1.60	47.18	42.72	10.10
795E	75	7.6	4.60	11.71	22.95	39.57	46.95	91.33	100.00	5.33	46.95	44.37	8.67
796E	145	7.0	6.56	14.63	25.66	45.02	52.57	91.84	100.00	4.45	52.57	39.27	8.16
797E	20	8.6	4.65	11.75	23.63	39.16	45.68	89.61	100.00	7.20	45.68	43.93	10.39
797E	40	5.9	3.70	10.36	20.80	38.08	45.26	89.99	100.00	2.50	45.26	44.72	10.01
797E	60	5.7	3.39	9.67	19.10	37.29	44.94	92.34	100.00	0.93	44.94	47.40	7.66
797E	80	5.7	3.84	11.05	21.00	39.50	46.02	89.89	100.00	1.50	46.02	43.87	10.11

Hole/Depth		CaCO3	Cumulative - Percentages										
		Equiv.	Sand (Sieve intervals)					%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
			10-20	10-40	10-60	10-140	10-230						
797E	100	6.1	3.60	9.96	18.73	37.11	43.80	88.11	100.00	3.03	43.80	44.31	11.89
797E	170	3.9	2.11	6.62	13.42	25.59	33.05	90.77	100.00	2.25	33.05	57.73	9.23
797E	190	3.7	2.50	7.78	15.23	31.75	36.96	92.49	100.00	0.90	36.96	55.53	7.51
797E	230	3.6	2.53	8.21	16.37	30.88	41.25	91.00	100.00	0.85	41.25	49.75	9.00
797E	250	4.4	3.36	6.97	13.23	24.03	31.13	88.66	100.00	3.72	31.13	57.52	11.34
797E	270	4.4	2.40	7.43	15.07	28.88	35.20	86.86	100.00	1.85	35.20	51.66	13.14
797E	290	5.2	4.26	8.90	15.15	24.65	29.28	82.43	100.00	10.82	29.28	53.14	17.57
797E	310	4.8	1.80	6.42	14.02	29.77	35.81	93.51	100.00	0.73	35.81	57.70	6.49
797E	335	2.3	2.38	7.25	15.81	28.46	36.44	89.36	100.00	1.59	36.44	52.93	10.64
797E	340	2.8	1.43	4.06	11.39	34.11	42.98	87.51	100.00	0.31	42.98	44.54	12.49
798E	10	3.6	2.58	7.78	17.87	32.82	38.33	85.41	100.00	0.41	38.33	47.08	14.59
798E	30	4.3	2.10	6.73	15.54	32.51	37.73	84.09	100.00	2.15	37.73	46.35	15.91
798E	50	3.2	2.04	6.58	14.23	30.52	36.28	84.38	100.00	0.50	36.28	48.10	15.62
798E	70	4.1	4.00	9.75	16.67	32.23	38.81	90.80	100.00	2.90	38.81	51.99	9.20
798E	90	13.2	4.43	10.39	18.61	33.05	40.03	89.86	100.00	3.10	40.03	49.83	10.14
798E	110	10.6	5.44	12.50	20.11	39.71	47.40	91.18	100.00	4.25	47.40	43.78	8.82
798E	130	9.3	4.25	7.00	9.84	31.31	38.58	89.82	100.00	6.70	38.58	51.24	10.18
798E	150	8.9	2.77	7.59	16.15	34.03	39.86	91.33	100.00	2.19	39.86	51.47	8.67
798E	170	8.7	2.80	6.92	16.85	31.16	35.26	88.95	100.00	2.50	35.26	53.68	11.05
798E	210	6.1	3.92	11.31	22.24	40.18	47.02	94.84	100.00	1.78	47.02	47.82	5.16
798E	230	4.6	2.16	4.55	16.93	35.24	43.43	92.94	100.00	3.49	43.43	49.52	7.06
798E	250	3.4	1.86	4.39	12.12	26.45	31.07	91.15	100.00	1.76	31.07	60.08	8.85
799E	10	10.2	1.80	4.30	11.54	28.67	35.50	85.22	100.00	0.59	35.50	49.72	14.78

Hole/Depth		CaCO3	- - - - - - - - - Cumulative - Percentages - - - - - - - - -									
		Equiv.	- - - - Sand (Sieve intervals) - - - - - -					%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
			10-20	10-40	10-60	10-140	10-230						
799E	20	3.0	1.87	5.04	13.17	28.24	34.56	86.43	100.00	2.55	34.56	51.87	13.57
799E	30	22.1	3.77	8.34	13.66	27.56	34.80	92.67	100.00	3.10	34.80	57.87	7.33
799E	40	20.0	1.90	3.97	9.22	20.17	24.31	93.97	100.00	2.30	24.31	69.65	6.03
739E	50	19.5	5.52	12.38	20.59	36.06	42.53	93.59	100.00	2.39	42.53	51.06	6.41
799E	100	8.2	3.91	8.97	20.62	45.09	51.71	94.97	100.00	1.43	51.71	43.27	5.03
799E	180	4.7	2.84	8.13	16.74	29.66	34.19	90.36	100.00	0.79	34.19	56.17	9.64
799E	185	6.1	5.14	13.27	24.74	38.19	43.21	91.09	100.00	2.09	43.21	47.88	8.91
801E	10	9.0	2.59	7.57	16.22	32.00	38.61	85.88	100.00	2.19	38.61	47.27	14.12
801E	20	9.1	2.47	7.47	14.89	28.93	35.29	85.71	100.00	0.70	35.29	50.42	14.29
801E	30	9.1	4.43	11.41	22.48	45.47	52.21	92.72	100.00	4.39	52.21	40.51	7.28
801E	40	11.3	2.19	5.01	9.80	21.93	26.36	87.44	100.00	1.50	26.36	61.07	12.56
801E	80	11.0	2.98	7.43	14.89	27.89	33.80	92.93	100.00	2.30	33.80	59.13	7.07
801E	85	5.8	3.47	10.25	20.90	38.25	43.67	95.32	100.00	1.40	43.67	51.66	4.68
801E	90	7.0	3.84	10.07	20.51	39.94	43.83	94.88	100.00	2.00	43.83	51.05	5.12
801E	190	6.7	4.13	10.91	20.46	36.19	41.81	91.47	100.00	2.30	41.81	49.66	8.53
801E	195	4.7	5.41	13.48	29.17	48.06	51.60	92.50	100.00	2.90	51.60	40.90	7.50
801E	200	6.1	3.62	10.17	22.98	40.18	46.37	96.19	100.00	3.23	46.37	49.82	3.81
802E	10	10.4	2.72	6.86	20.33	40.02	47.88	93.76	100.00	2.10	47.88	45.88	6.24
802E	15	8.1	2.50	6.99	17.53	38.17	46.98	94.82	100.00	3.02	46.98	47.83	5.18
802E	22	11.3	1.37	3.76	11.71	34.00	42.06	92.55	100.00	2.20	42.06	50.49	7.45
802E	25	11.2	1.81	5.35	16.63	36.06	42.96	92.95	100.00	1.09	42.96	49.98	7.05
802E	65	26.6	8.59	16.37	27.26	44.68	49.78	93.84	100.00	24.30	49.78	44.06	6.16
802E	67	19.6	4.48	10.86	17.73	36.41	42.61	92.51	100.00	3.90	42.61	49.90	7.49

Hole/Depth		CaCO3	- - - - - - - - - - Cumulative - Percentages - - - - - - - - - -										
		Equiv.	- - - - Sand (Sieve intervals) - - - - - -					%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
			10-20	10-40	10-60	10-140	10-230						
802E	75	18.2	3.39	7.32	14.05	27.42	32.76	96.98	100.00	7.56	32.76	64.21	3.02
802E	85	13.7	4.57	10.98	22.87	36.89	40.39	90.24	100.00	5.51	40.39	49.85	9.76
802E	95	7.0	3.36	9.08	19.05	35.14	39.19	95.06	100.00	3.50	39.19	55.87	4.94
802E	110	7.8	4.33	13.86	33.81	49.60	51.93	92.89	100.00	3.32	51.93	40.96	7.11
802E	115	9.7	3.56	10.14	19.99	39.69	44.82	97.33	100.00	5.48	44.82	52.52	2.67
802E	140	2.9	2.10	6.88	16.96	31.64	37.62	97.18	100.00	4.28	37.62	59.56	2.82
802E	175	6.9	2.82	7.47	11.81	19.37	22.76	97.24	100.00	1.80	22.76	74.47	2.76
802E	185	7.0	2.84	7.72	13.02	21.87	25.65	96.73	100.00	2.10	25.65	71.08	3.27
802E	195	3.9	0.80	2.39	12.29	33.64	40.16	92.59	100.00	0.10	40.16	52.43	7.41
804E	10	4.0	2.39	4.48	6.95	11.42	14.60	82.15	100.00	0.70	14.60	67.55	17.85
804E	20	9.8	0.23	0.46	0.46	0.75	0.85	98.85	100.00	0.0	0.85	98.00	1.15
804E	25	9.1	0.04	0.33	0.58	0.82	1.07	87.52	100.00	0.08	1.07	86.46	12.48
804E	30	10.9	0.22	0.75	1.37	2.41	3.03	90.80	100.00	0.08	3.03	87.77	9.20
804E	55	17.1	4.80	10.70	20.34	37.05	42.09	91.40	100,00	3.40	42.09	49.30	8.60
804E	60	17.4	3.97	9.59	16.94	34.04	40.35	93.24	100.00	2.77	40.35	52.89	6.76
804E	65	15.6	3.62	7.73	15.86	32.00	37.56	91.79	100.00	4.61	37.56	54.22	8.21
804E	70	14.5	3.57	8.44	17.65	34.82	38.97	90.06	100.00	3.50	38.97	51.09	9.94
804E	75	14.9	2.84	7.81	19.11	33.76	38.29	91.49	100.00	1.76	38.29	53.20	8.51
804E	80	15.0	3.93	9.36	18.28	34.69	40.50	91.12	100.00	4.10	40.50	50.62	8.88
804E	95	15.0	4.62	10.80	21.56	42.11	48.28	92.62	100.00	2.50	48.28	44.34	7.38
804E	100	13.7	3.40	8.72	17.00	35.77	39.78	91.40	100.00	5.60	39.78	51.62	8.60
804E	105	11.3	3.22	9.17	11.08	32.30	38.00	91.18	100.00	2.75	38.00	53.19	8.82
804E	108	9.7	4.60	11.70	19.41	38.66	47.31	88.68	100.00	3.70	47.31	41.37	11.32

Hole/Depth		CaCO3	- - - - - - - - - Cumulative - Percentages - - - - - - - - -										
		Equiv.	- - - - Sand (Sieve intervals) - - - - - -					%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
			10-20	10-40	10-60	10-140	10-230						
804E	110	10.1	5.64	11.60	20.98	37.41	44.72	94.38	100.00	2.65	44.72	49.66	5.62
804E	115	9.4	4.85	11.57	20.18	37.33	43.93	98.34	100.00	2.99	43.93	54.41	1.66
804E	120	9.8	4.45	11.29	20.45	38.89	45.71	95.33	100.00	2.29	45.71	49.63	4.67
804E	125	5.4	4.20	13.02	21.50	35.36	41.87	95.64	100.00	3.08	41.87	53.76	4.36
804E	130	5.2	3.33	6.37	12.37	23.51	29.22	89.25	100.00	3.22	29.22	60.03	10.75
804E	185	2.3	0.60	1.50	1.97	2.53	4.26	98.96	100.00	0.0	4.26	94.69	1.04
804E	190	5.1	0.08	0.19	0.54	10.62	22.09	93.00	100.00	0.0	22.09	70.91	7.00
804E	195	4.3	0.45	0.87	1.22	1.82	2.73	92.51	100.00	0.10	2.73	89.78	7.49
804E	200	4.3	0.62	1.13	2.28	4.11	4.84	93.64	100.00	0.12	4.84	88.80	6.36
804E	205	6.1	2.93	7.49	15.00	26.92	31.74	92.02	100.00	1.18	31.74	60.28	7.98
804E	210	6.9	4.46	6.48	13.93	26.18	31.54	91.76	100.00	3.80	31.54	60.22	8.24
804E	215	5.1	2.37	6.81	9.81	20.71	25.21	89.33	100.00	1.40	25.21	64.12	10.67
806E	5	10.4	2.50	7.27	13.27	28.90	35.79	89.49	100.00	1.58	35.79	53.70	10.51
806E	10	10.4	2.35	7.14	13.43	30.46	36.01	89.70	100.00	1.02	36.01	53.69	10.30
806E	15	8.0	2.17	5.60	10.86	22.04	26.47	83.80	100.00	0.20	26.47	57.33	16.20
806E	20	14.1	4.06	10.44	17.57	37.15	44.68	92.80	100.00	3.49	44.68	48.12	7.20
806E	30	15.6	3.92	10.11	18.48	37.74	43.83	96.10	100.00	3.08	43.83	52.27	3.90
806E	35	16.1	3.99	10.02	17.46	36.02	42.69	98.25	100.00	2.12	42.69	55.56	1.75
806E	40	16.6	4.24	10.11	17.39	35.62	42.72	92.75	100.00	9.50	42.72	50.04	7.25
806E	50	16.0	3.88	10.29	17.04	35.14	42.80	96.10	100.00	3.10	42.80	53.30	3.90
806E	55	15.6	3.94	9.64	16.52	34.61	41.04	96.09	100.00	5.20	41.04	55.05	3.91
806E	65	8.4	4.18	11.74	20.66	40.63	47.93	95.04	100.00	1.50	47.93	47.12	4.96
806E	70	7.9	4.36	12.22	22.07	43.29	49.86	97.13	100.00	4.60	49.86	47.27	2.87
806E	75	8.7	3.89	11.26	23.17	43.12	49.81	87.63	100.00	3.19	49.81	37.82	12.37

Hole/Depth		CaCO3	Cumulative - Percentages										
		Equiv.	Sand (Sieve intervals)					%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
			10-20	10-40	10-60	10-140	10-230						
806E	85	7.5	4.34	11.90	23.03	41.59	48.63	90.02	100.00	4.40	48.63	41.40	9.98
806E	90	7.3	4.35	12.08	22.74	42.15	48.78	71.04	100.00	6.21	48.78	22.26	28.96
806E	95	7.9	4.22	12.71	23.35	41.52	49.05	92.92	100.00	1.52	49.05	43.87	7.08
806E	100	8.0	4.02	12.14	23.76	45.40	51.41	93.09	100.00	1.10	51.41	41.69	6.91
806E	105	9.4	4.60	11.81	23.27	42.13	48.81	84.41	100.00	6.99	48.81	35.59	15.59
806E	115	9.8	3.74	10.81	19.48	35.57	42.92	90.90	100.00	1.78	42.92	47.98	9.10
806E	120	9.8	4.38	12.12	22.33	39.54	46.81	94.18	100.00	2.71	46.81	47.37	5.82
806E	125	8.6	4.65	11.71	21.24	37.28	44.33	88.07	100.00	2.39	44.33	43.74	11.93
807E	20	7.1	2.40	7.34	16.52	34.00	38.15	82.20	100.00	0.80	38.15	44.05	17.80
807E	30	5.9	3.57	8.14	16.52	29.24	33.27	82.11	100.00	0.90	33.27	48.84	17.89
807E	40	5.7	5.58	10.49	18.55	32.60	36.82	87.34	100.00	2.09	36.82	50.52	12.66
807E	50	8.4	2.14	5.38	13.43	29.67	34.83	90.23	100.00	2.10	34.83	55.40	9.77
807E	60	8.3	1.82	4.78	10.71	21.93	25.49	83.93	100.00	0.25	25.49	58.44	16.07
807E	70	8.7	1.70	4.89	11.42	23.45	26.66	84.59	100.00	0.26	26.66	57.93	15.41
807E	80	6.5	3.12	7.19	15.40	31.71	37.24	90.55	100.00	7.81	37.24	53.31	9.45
807E	90	8.0	7.01	12.37	20.45	37.21	41.32	91.58	100.00	12.84	41.32	50.25	8.42
807E	125	9.3	3.70	8.76	17.49	35.61	38.29	95.00	100.00	3.80	38.29	56.71	5.00
807E	135	6.2	4.26	11.41	21.74	40.95	45.27	93.72	100.00	5.63	45.27	48.45	6.28
807E	145	9.4	6.39	13.99	25.28	44.58	48.58	92.38	100.00	5.50	48.58	43.80	7.62
807E	155	6.9	4.23	9.86	21.56	40.33	44.08	91.15	100.00	3.66	44.08	47.07	8.85
807E	166	8.0	5.51	13.71	30.28	52.60	56.66	97.56	100.00	1.90	56.66	40.90	2.44
807E	185	6.6	3.58	7.66	17.47	31.46	36.19	87.30	100.00	2.60	36.19	51.11	12.70
807E	200	5.9	3.87	10.29	23.02	40.85	46.98	90.91	100.00	9.73	46.98	43.93	9.09
807E	206	8.3	4.36	8.32	21.76	30.71	33.03	86.22	100.00	8.08	33.03	53.18	13.78

Hole/Depth		CaCO3	- - - - - - - - - - Cumulative - Percentages - - - - - - - - - -										
		Equiv.	- - - - Sand (Sieve intervals) - - - - - -					%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
			10-20	10-40	10-60	10-140	10-230						
807E	230	6.2	7.59	15.32	28.46	41.09	44.57	87.85	100.00	1.78	44.57	43.28	12.15
807E	265	7.6	3.55	8.72	20.00	29.96	32.59	88.16	100.00	2.42	32.59	55.58	11.84
807E	270	7.3	4.31	10.43	23.70	36.98	40.74	91.54	100.00	1.98	40.74	50.80	8.46
807E	280	7.5	3.89	9.47	21.63	32.27	34.64	89.91	100.00	1.69	34.64	55.28	10.09
807E	290	5.4	2.26	5.82	14.26	22.65	24.61	90.83	100.00	1.30	24.61	66.22	9.17
807E	300	5.8	1.21	3.22	8.87	17.84	20.21	83.74	100.00	0.45	20.21	63.54	16.26
807E	310	6.1	3.25	7.02	17.36	26.68	28.34	85.24	100.00	0.79	28.34	56.90	14.76
808E	5	5.2	1.06	3.99	9.47	18.50	20.89	75.06	100.00	0.20	20.89	54.16	24.94
808E	25	4.6	2.27	5.22	13.03	26.59	30.70	84.55	100.00	0.61	30.70	53.84	15.45
808E	35	6.1	2.85	8.46	21.47	32.96	36.16	82.12	100.00	1.18	36.16	45.96	17.88
808E	45	7.7	1.81	5.96	16.23	29.88	34.27	84.41	100.00	1.28	34.27	50.13	15.59
808E	55	9.5	2.63	6.69	17.18	34.78	39.88	85.39	100.00	2.61	39.88	45.51	14.61
808E	65	5.0	1.81	6.55	18.43	31.74	36.20	91.62	100.00	1.09	36.20	55.42	8.38
808E	75	5.7	2.31	6.90	19.72	31.13	33.50	89.37	100.00	2.38	33.50	55.87	10.63
808E	85	5.4	1.92	5.14	16.34	30.25	34.07	88.13	100.00	1.08	34.07	54.06	11.87
808E	95	5.1	1.71	6.07	17.58	29.36	32.97	90.22	100.00	0.93	32.97	57.25	9.78
808E	105	1.8	1.33	5.14	48.60	63.70	65.86	87.82	100.00	0.20	65.86	21.96	12.18
808E	125	5.7	1.74	5.88	19.38	31.88	35.66	88.80	100.00	0.82	35.66	53.14	11.20
808E	134	6.6	1.99	4.55	14.66	29.74	33.35	88.45	100.00	4.70	33.35	55.11	11.55
808E	185	1.2	1.91	6.98	14.97	26.68	28.98	89.27	100.00	1.35	28.98	60.29	10.73
808E	195	2.8	2.90	7.39	24.44	45.33	51.93	89.84	100.00	4.45	51.93	37.91	10.16
808E	206	3.9	1.23	2.63	5.63	11.21	13.64	87.19	100.00	1.59	13.64	73.55	12.81
808E	215	7.3	0.67	2.22	11.05	20.36	21.75	92.83	100.00	0.0	21.75	71.07	7.17
808E	320	7.5	3.61	9.18	20.79	32.10	34.93	93.42	100.00	1.40	34.93	58.48	6.58

Hole/Depth		CaCO3	- - - - - - - - - - Cumulative - Percentages	- - - - - - - - - -								
		Equiv.	- - - - Sand (Sieve intervals)	- - - - - -				%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
			10-20	10-40	10-60	10-140	10-230						
808E	325	7.6	4.82	11.41	23.37	36.36	40.78	91.87	100.00	1.25	40.78	51.09	8.13
808E	330	7.9	4.21	10.50	21.20	32.21	36.06	90.49	100.00	2.23	36.06	54.44	9.51
808E	335	6.8	3.52	8.65	19.02	28.87	35.31	90.60	100.00	2.09	35.31	55.29	9.40
808E	340	5.9	2.24	5.04	12.73	20.96	24.27	90.46	100.00	1.33	24.27	66.19	9.54
809E	15	2.3	1.77	5.62	15.14	26.53	29.75	84.98	100.00	0.51	29.75	55.23	15.02
809E	25	2.5	2.42	7.17	17.07	26.37	28.75	83.76	100.00	1.49	28.75	55.01	16.24
809E	35	3.7	2.19	6.97	17.39	30.60	35.71	90.92	100.00	0.69	35.71	55.20	9.08
809E	45	2.3	6.12	14.43	27.26	40.08	44.91	86.21	100.00	4.19	44.91	41.30	13.79
809E	55	3.4	4.58	10.68	24.41	36.79	40.87	90.29	100.00	5.00	40.87	49.42	9.71
809E	65	2.9	2.89	8.54	20.73	32.26	39.03	90.96	100.00	0.80	39.03	51.93	9.04
809E	75	3.5	2.65	8.24	21.56	34.19	39.25	93.05	100.00	1.29	39.25	53.81	6.95
809E	85	2.2	2.15	6.95	17.81	29.44	33.70	89.45	100.00	0.90	33.70	55.75	10.55
809E	95	2.3	3.14	8.36	20.69	33.33	38.38	92.15	100.00	5.00	38.38	53.77	7.85
809E	105	1.9	3.18	8.55	20.62	37.44	43.66	93.25	100.00	1.71	43.66	49.59	6.75
809E	115	1.3	4.21	11.99	23.24	34.82	38.24	88.99	100.00	2.90	38.24	50.75	11.01
828E	10	5.9	2.55	9.58	22.46	39.30	44.40	85.83	100.00	2.45	44.40	41.43	14.17
828E	20	6.8	2.13	9.26	24.22	40.78	45.63	92.81	100.00	0.65	45.63	47.18	7.19
828E	30	6.3	3.71	10.71	25.77	42.14	46.72	91.93	100.00	0.99	46.72	45.20	8.07
828E	40	5.9	3.74	11.02	25.92	38.94	43.97	89.29	100.00	1.49	43.97	45.32	10.71
828E	50	7.1	3.55	10.82	24.85	41.93	47.33	89.97	100.00	1.12	47.33	42.64	10.03
828E	60	8.1	3.24	9.48	22.88	38.94	44.31	95.33	100.00	3.30	44.31	51.02	4.67
828E	70	8.6	3.36	9.77	22.89	38.99	43.71	93.12	100.00	1.40	43.71	49.40	6.88

Hole/Depth		CaCO3	Cumulative - Percentages								%Sand	%Silt	%Clay
		Equiv.	Sand (Sieve intervals)					%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh			
			10-20	10-40	10-60	10-140	10-230						
829E	5	1.0	2.24	6.90	19.64	34.69	39.15	81.40	100.00	0.45	39.15	42.25	18.60
829E	10	8.6	1.43	6.84	25.24	52.96	59.33	90.97	100.00	0.30	59.33	31.64	9.03
829E	15	9.2	2.38	6.74	14.78	34.25	40.61	99.45	100.00	0.90	40.61	58.84	0.55
829E	20	9.3	2.17	6.66	16.11	33.19	39.27	84.48	100.00	0.50	39.27	45.21	15.52
829E	25	8.6	5.54	11.51	21.47	38.62	44.18	85.83	100.00	14.48	44.18	41.64	14.17
829E	30	9.1	2.44	6.77	16.50	36.59	42.26	86.69	100.00	2.50	42.26	44.43	13.31
829E	35	9.0	2.31	6.67	15.56	35.53	42.95	86.82	100.00	1.35	42.95	43.87	13.18
829E	40	8.9	2.21	6.12	15.55	29.60	35.99	82.81	100.00	1.02	35.99	46.82	17.19
829E	45	9.0	1.84	5.32	14.56	28.84	34.58	83.87	100.00	0.50	34.58	49.29	16.13
829E	50	9.1	2.11	6.24	14.67	30.43	36.36	83.30	100.00	0.56	36.36	46.94	16.70
829E	55	9.2	1.95	6.02	15.44	27.60	32.62	81.07	100.00	1.40	32.62	48.45	18.93
829E	60	8.1	1.60	4.93	11.09	22.71	26.70	78.04	100.00	1.12	26.70	51.35	21.96
829E	65	20.7	3.38	9.51	18.92	29.06	32.30	91.69	100.00	1.70	32.30	59.39	8.31
829E	70	17.3	3.47	9.06	19.38	33.12	37.24	90.69	100.00	1.20	37.24	53.45	9.31
829E	75	11.6	2.45	6.40	14.79	23.32	26.44	85.54	100.00	1.39	26.44	59.10	14.46
829E	80	12.0	3.78	8.78	17.19	28.66	33.05	84.69	100.00	3.38	33.05	51.64	15.31
829E	85	12.1	2.28	5.62	11.83	19.14	21.76	83.05	100.00	0.81	21.76	61.29	16.95
829E	90	7.7	5.70	14.70	32.32	49.70	54.93	91.99	100.00	6.99	54.93	37.06	8.01
829E	95	13.2	4.53	11.62	54.09	31.86	34.75	85.68	100.00	3.70	34.75	50.92	14.32
830E	5	7.2	2.04	5.43	10.80	28.26	38.61	90.60	100.00	0.70	38.61	52.00	9.40
830E	10	5.5	1.50	4.42	9.56	19.84	24.70	84.64	100.00	0.20	24.70	59.93	15.36
830E	45	16.3	4.08	9.96	18.61	36.20	44.09	93.63	100.00	4.20	44.09	49.54	6.37
830E	65	16.4	4.85	12.74	23.47	43.33	49.94	94.09	100.00	3.71	49.94	44.15	5.91
830E	70	9.2	5.53	13.33	23.36	43.66	49.86	93.32	100.00	3.70	49.86	43.46	6.68

Hole/Depth		CaCO3	Cumulative - Percentages										
		Equiv.	Sand (Sieve intervals)					%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
			10-20	10-40	10-60	10-140	10-230						
830E	75	8.9	5.06	12.95	24.68	44.12	51.04	95.08	100.00	10.26	51.04	44.04	4.92
830E	80	8.4	4.28	11.76	22.81	44.46	51.68	93.44	100.00	2.15	51.68	41.76	6.56
830E	85	8.3	5.22	12.73	24.48	45.32	52.29	93.24	100.00	3.50	52.29	40.96	6.76
830E	90	9.0	4.56	12.44	24.79	46.13	53.36	94.75	100.00	3.09	53.36	41.39	5.25
830E	95	7.9	4.58	12.31	24.74	45.45	52.61	93.54	100.00	1.88	52.61	40.93	6.46
830E	120	8.6	5.09	13.56	27.67	49.91	57.19	95.09	100.00	3.15	57.19	37.90	4.91
830E	153	9.9	3.76	9.97	18.09	35.35	42.55	93.69	100.00	5.50	42.55	51.15	6.31
830E	164	7.7	3.41	8.68	17.61	33.37	39.54	89.84	100.00	9.28	39.54	50.29	10.16
831E	10	7.3	1.39	4.80	11.22	22.31	26.98	80.99	100.00	0.30	26.98	54.00	19.01
831E	40	12.0	4.46	10.62	19.47	37.40	44.41	92.65	100.00	10.65	44.41	48.24	7.35
831E	60	10.8	3.73	9.81	19.61	35.36	42.29	94.63	100.00	2.40	42.29	52.34	5.37
831E	80	10.9	4.75	11.59	21.99	40.65	48.20	94.32	100.00	1.71	48.20	46.12	5.68
831E	100	8.0	4.65	11.75	24.29	42.32	49.59	94.39	100.00	7.80	49.59	44.81	5.61
831E	140	6.9	4.34	11.27	22.62	38.76	46.00	91.80	100.00	1.48	46.00	45.80	8.20
831E	160	5.7	4.44	10.94	20.32	36.42	42.90	94.80	100.00	2.32	42.90	51.90	5.20
831E	180	6.4	5.92	13.82	23.60	39.05	45.30	90.47	100.00	4.30	45.30	45.17	9.53
831E	200	7.3	4.89	12.00	21.68	37.50	44.24	90.64	100.00	3.18	44.24	46.40	9.36
831E	220	7.0	3.85	10.23	18.97	34.73	41.72	93.01	100.00	3.00	41.72	51.29	6.99
831E	280	4.7	5.01	12.24	23.41	38.29	43.76	92.62	100.00	6.10	43.76	48.86	7.38
832E	10	7.3	4.78	9.55	20.21	33.20	38.14	88.85	100.00	6.18	38.14	50.72	11.15
832E	20	8.7	2.27	6.31	15.00	29.01	34.76	86.20	100.00	0.85	34.76	51.44	13.80
832E	30	8.3	2.29	6.49	18.64	30.52	35.22	87.40	100.00	0.90	35.22	52.18	12.60
832E	40	8.0	2.60	6.60	13.57	28.45	34.38	87.38	100.00	1.69	34.38	53.00	12.62

Hole/Depth		CaCO3	- - - - - - - - - - Cumulative -	Percentages	- - - - - - - - - -							
		Equiv.	- - - - Sand (Sieve intervals) - - - - - -					%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
			10-20	10-40	10-60	10-140	10-230						
832E	50	6.4	1.56	5.14	11.81	23.25	28.79	85.54	100.00	0.51	28.79	56.75	14.46
832E	60	7.5	2.79	8.02	16.55	30.91	43.22	87.37	100.00	1.95	43.22	44.15	12.63
832E	70	10.5	3.22	7.06	15.57	30.65	38.30	85.79	100.00	4.30	38.30	47.49	14.21
832E	80	9.1	1.73	5.36	9.91	18.05	25.50	80.17	100.00	0.69	25.50	54.67	19.83
832E	90	10.2	1.40	4.11	11.00	21.77	26.92	87.95	100.00	0.99	26.92	61.03	12.05
832E	100	17.0	0.75	2.46	11.89	27.46	34.43	86.74	100.00	0.30	34.43	52.31	13.26
832E	110	8.5	1.20	3.23	7.91	15.42	21.14	85.11	100.00	0.70	21.14	63.98	14.89
832E	120	8.8	0.97	2.82	10.19	22.33	29.10	87.45	100.00	0.20	29.10	58.35	12.55
832E	130	21.2	3.08	7.92	16.89	31.06	36.66	89.60	100.00	3.14	36.66	52.94	10.40
832E	140	15.8	3.73	9.25	18.71	33.74	40.38	91.31	100.00	1.90	40.38	50.92	8.69
832E	150	7.2	2.84	7.75	11.20	16.30	20.10	85.36	100.00	0.51	20.10	65.26	14.64
832E	160	7.2	2.90	8.87	19.09	35.45	41.57	88.60	100.00	1.50	41.57	47.03	11.40
832E	170	6.1	2.39	6.81	16.21	28.24	32.44	81.59	100.00	0.58	32.44	49.15	18.41
832E	180	6.6	1.55	4.93	16.62	32.11	37.88	87.25	100.00	0.49	37.88	49.37	12.75
832E	190	3.8	5.17	14.54	25.87	41.74	48.69	90.10	100.00	1.99	48.69	41.40	9.90
832E	198	3.7	1.90	5.04	10.16	17.57	20.86	79.93	100.00	1.24	20.86	59.07	20.07
833E	10	5.0	3.57	7.70	15.36	23.97	27.55	85.14	100.00	1.40	27.55	57.59	14.86
833E	20	5.5	2.19	5.17	13.13	23.49	26.44	89.99	100.00	3.50	26.44	63.55	10.01
833E	30	5.7	2.11	6.14	14.96	27.38	31.24	88.11	100.00	2.10	31.24	56.87	11.89
833E	40	7.5	2.14	6.17	14.95	26.24	29.29	86.87	100.00	1.10	29.29	57.57	13.13
833E	50	5.9	5.21	9.94	19.85	32.68	36.73	88.84	100.00	1.50	36.73	52.11	11.16
833E	60	6.2	4.26	9.07	17.28	28.59	32.50	87.39	100.00	4.10	32.50	54.89	12.61
833E	70	7.2	1.17	3.73	9.32	18.60	22.29	81.95	100.00	0.40	22.29	59.66	18.05
833E	80	5.1	4.25	9.28	10.24	32.44	37.35	91.96	100.00	5.85	37.35	54.62	8.04

Hole/Depth		CaCO3 Equiv.	Cumulative - Percentages: Sand (Sieve intervals) 10-20	10-40	10-60	10-140	10-230	%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
833E	90	5.2	2.58	7.41	16.54	31.52	36.21	92.05	100.00	1.44	36.21	55.83	7.95
833E	100	4.6	3.38	9.14	19.31	36.20	41.39	93.46	100.00	2.80	41.39	52.07	6.54
833E	115	13.0	3.98	9.85	19.62	33.81	38.56	92.39	100.00	1.22	38.56	53.83	7.61
833E	125	14.3	3.36	8.30	15.80	27.47	31.89	91.48	100.00	3.62	31.89	59.59	8.52
833E	135	10.9	3.30	7.22	13.95	23.97	27.26	87.93	100.00	1.70	27.26	60.67	12.07
833E	200	3.0	2.97	7.42	16.01	30.74	37.06	91.53	100.00	3.00	37.06	54.47	8.47
833E	210	2.1	2.67	8.33	18.20	32.71	38.93	92.68	100.00	0.70	38.93	53.75	7.32
833E	220	1.9	2.25	7.10	16.47	30.60	36.56	91.97	100.00	0.60	36.56	55.41	8.03
833E	230	2.9	2.66	6.69	15.04	28.73	33.90	89.37	100.00	1.28	33.90	55.47	10.63
833E	240	4.6	1.91	5.42	13.26	24.78	29.57	86.64	100.00	0.40	29.57	57.07	13.36
833E	250	4.4	3.34	9.06	15.90	28.01	32.60	90.24	100.00	0.51	32.60	57.64	9.76
833E	260	4.4	1.85	6.25	15.50	27.53	32.19	88.38	100.00	0.20	32.19	56.19	11.62
833E	270	3.5	2.15	6.04	16.36	27.99	33.13	91.39	100.00	0.35	33.13	58.26	8.61
833E	280	2.5	0.19	0.86	1.24	6.39	9.43	90.95	100.00	0.0	9.43	81.52	9.05
834E	5	1.4	2.26	7.84	17.60	32.45	36.89	84.06	100.00	1.19	36.89	47.97	15.14
834E	15	4.4	1.95	6.54	15.80	30.16	35.39	86.27	100.00	0.20	35.39	50.88	13.73
834E	25	1.4	2.99	8.27	18.96	33.41	39.33	87.51	100.00	1.20	39.33	48.18	12.49
834E	35	5.7	4.12	12.05	27.22	46.16	51.44	92.72	100.00	2.20	51.44	41.28	7.28
834E	45	8.7	4.74	12.20	25.03	42.84	48.54	92.53	100.00	1.70	48.54	43.99	7.47
834E	55	7.9	3.50	9.53	22.10	36.81	41.78	91.24	100.00	1.92	41.78	49.46	8.76
834E	65	7.0	5.06	13.03	26.46	40.63	45.24	91.82	100.00	3.28	45.24	46.57	8.18
834E	85	9.0	4.45	11.80	25.25	38.78	43.08	87.84	100.00	1.23	43.08	44.76	12.16
834E	95	6.1	3.73	9.29	20.23	33.62	38.41	90.04	100.00	1.98	38.41	51.62	9.96
834E	160	4.0	3.70	9.88	22.50	38.00	42.55	90.70	100.00	1.65	42.55	48.15	9.30

Hole/Depth		CaCO3	Cumulative - Percentages										
		Equiv.	Sand (Sieve intervals)					%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
			10-20	10-40	10-60	10-140	10-230						
834E	170	4.3	3.67	9.64	22.16	37.45	42.00	90.06	100.00	1.07	42.00	48.06	9.94
834E	180	3.5	2.38	7.12	19.07	32.02	36.60	89.26	100.00	1.73	36.60	52.66	10.74
834E	190	3.7	2.88	8.77	21.95	36.86	41.59	88.68	100.00	1.30	41.59	47.09	11.32
835E	10	4.0	2.08	6.35	15.41	28.77	34.36	79.96	100.00	1.54	34.36	45.60	20.04
835E	30	3.7	2.12	6.59	15.96	29.02	34.99	82.71	100.00	1.12	34.99	47.72	17.29
835E	40	3.7	2.12	6.94	16.70	29.19	35.54	83.39	100.00	0.50	35.54	47.85	16.61
835E	50	3.8	1.36	5.12	13.35	25.97	31.54	83.13	100.00	1.55	31.54	51.59	16.87
835E	60	3.9	2.01	6.18	13.71	24.76	30.14	83.57	100.00	1.90	30.14	53.42	16.43
835E	70	3.9	1.88	6.33	15.12	28.98	35.58	88.54	100.00	0.45	35.58	52.96	11.46
835E	80	8.1	2.42	7.29	17.27	29.54	37.72	86.51	100.00	0.63	37.72	48.79	13.49
835E	90	6.1	2.24	6.36	13.92	27.60	33.26	87.69	100.00	1.40	33.26	54.43	12.31
835E	100	6.3	4.48	10.75	16.48	26.09	30.59	93.46	100.00	7.50	30.59	62.88	6.54
835E	150	4.4	3.11	9.76	24.54	49.32	59.92	87.54	100.00	1.20	59.92	27.62	12.46
835E	160	3.5	3.03	9.45	17.82	34.15	41.83	90.83	100.00	0.95	41.83	49.00	9.17
835E	170	2.5	2.27	7.41	15.56	28.74	35.57	91.10	100.00	0.38	35.57	55.53	8.90
835E	180	1.2	2.22	7.71	15.95	30.49	37.48	92.35	100.00	1.18	37.48	54.87	7.65
836E	30	7.3	1.79	5.63	12.79	26.83	33.01	84.11	100.00	1.81	33.01	51.10	15.89
836E	60	7.4	2.44	6.44	15.11	29.95	36.15	87.00	100.00	1.49	36.15	50.86	13.00
836E	100	7.4	3.30	9.38	20.32	34.81	41.00	88.69	100.00	2.42	41.00	47.69	11.31
836E	140	6.4	0.97	4.54	13.20	28.04	34.13	84.35	100.00	1.35	34.13	50.22	15.65
836E	200	2.6	1.53	6.07	15.68	29.11	35.68	90.43	100.00	0.34	35.68	54.75	9.57

Hole/Depth		CaCO3	Cumulative - Percentages										
		Equiv.	Sand (Sieve intervals)					%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
			10-20	10-40	10-60	10-140	10-230						
952E	10	6.8	2.21	6.36	12.61	24.74	30.82	84.23	100.00	1.15	30.82	53.42	15.77
952E	20	7.6	3.09	7.63	14.69	28.00	33.55	85.29	100.00	6.56	33.55	51.73	14.71
952E	24	7.1	2.20	5.67	11.27	22.53	28.86	80.19	100.00	3.12	28.86	51.33	19.81
952E	30	6.5	2.80	7.29	13.14	23.48	27.22	82.22	100.00	1.10	27.22	55.00	17.78
952E	40	4.9	4.74	11.01	18.94	32.05	37.39	85.78	100.00	10.80	37.39	48.39	14.22
952E	65	5.1	3.02	8.65	17.48	31.88	38.41	89.23	100.00	2.83	38.41	50.82	10.77
952E	70	6.2	3.27	9.22	17.05	33.31	39.29	88.43	100.00	1.01	39.29	49.14	11.57
952E	75	5.7	4.02	9.81	16.90	32.18	38.73	86.41	100.00	8.50	38.73	47.68	13.59
952E	80	6.0	4.67	11.31	18.92	33.50	39.60	89.63	100.00	12.40	39.60	50.02	10.37
952E	95	7.3	3.85	11.17	20.73	38.51	45.55	89.85	100.00	4.40	45.55	44.30	10.15
952E	105	6.8	3.23	9.85	18.37	35.65	43.44	87.37	100.00	0.80	43.44	43.93	12.63
952E	110	6.8	3.59	9.56	18.26	33.62	39.34	86.97	100.00	8.98	39.34	47.62	13.03
953E	6	3.9	0.60	6.56	14.84	26.83	31.75	79.46	100.00	0.20	31.75	47.72	20.54
953E	60	4.4	3.20	8.55	16.65	29.97	37.15	81.90	100.00	4.30	37.15	44.74	18.10
953E	70	2.7	2.52	7.84	16.22	30.90	37.98	81.01	100.00	0.50	37.98	43.02	18.99
953E	80	2.1	1.99	7.05	15.91	30.01	36.83	81.97	100.00	0.91	36.83	45.14	18.03
953E	90	3.2	1.16	4.61	11.78	27.41	34.51	88.85	100.00	1.31	34.51	54.34	11.15
953E	100	3.0	1.96	7.56	17.12	31.47	37.50	87.65	100.00	7.75	37.50	50.14	12.35
953E	105	6.2	3.72	9.64	20.07	36.35	42.37	86.22	100.00	5.88	42.37	43.85	13.78
953E	110	2.7	1.51	6.49	14.02	27.38	34.32	85.42	100.00	0.20	34.32	51.10	14.58
953E	120	2.5	1.12	4.77	13.25	26.78	33.54	87.56	100.00	0.30	33.54	54.02	12.44
953E	130	2.5	1.18	5.48	13.73	27.37	32.95	87.53	100.00	0.51	32.95	54.58	12.47
953E	140	2.7	1.37	5.72	14.15	27.55	33.34	88.33	100.00	0.32	33.34	54.99	11.67
953E	151	4.1	1.15	4.35	10.41	19.95	24.92	89.04	100.00	1.00	24.92	64.12	10.96

Hole/Depth	CaCO3	- - - - - - - - - - Cumulative - Percentages										
	Equiv.	- - - - Sand (Sieve intervals) - - - - - -					%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
		10-20	10-40	10-60	10-140	10-230						
953E 160	4.0	1.16	3.94	10.36	22.58	30.63	88.00	100.00	0.31	30.63	57.37	12.00
956E 10	6.6	3.06	8.65	15.55	32.57	39.10	86.34	100.00	3.62	39.10	47.24	13.66
956E 20	5.1	1.68	5.14	9.96	23.14	31.17	88.28	100.00	2.09	31.17	57.11	11.72
956E 30	4.6	1.69	5.24	9.67	22.74	30.06	87.78	100.00	1.41	30.06	57.72	12.22
956E 40	5.2	2.07	5.37	11.53	24.86	31.92	93.25	100.00	0.90	31.92	61.33	6.75
956E 50	4.0	3.45	8.55	14.19	27.73	34.40	92.90	100.00	2.82	34.40	58.49	7.10
956E 60	4.4	2.65	7.58	13.65	27.89	34.67	97.32	100.00	2.00	34.67	62.64	2.68
956E 70	4.0	2.75	9.15	18.50	32.43	38.41	92.37	100.00	2.83	38.41	53.96	7.63
956E 80	3.8	2.16	6.64	13.09	26.99	34.14	93.09	100.00	0.89	34.14	58.95	6.91
956E 90	4.1	2.21	6.39	14.62	29.44	36.22	91.62	100.00	1.20	36.22	55.39	8.38
956E 100	4.8	2.06	5.77	12.96	29.09	36.35	72.31	100.00	1.50	36.35	35.96	27.69
956E 110	5.2	1.75	5.26	11.47	25.82	34.40	90.81	100.00	1.39	34.40	56.41	9.19
956E 120	4.1	1.47	4.83	11.29	25.00	32.94	76.03	100.00	2.10	32.94	43.08	23.97
956E 130	4.7	1.48	4.38	9.70	21.92	27.54	88.35	100.00	1.30	27.54	60.81	11.65
956E 140	4.3	1.61	4.66	10.39	24.22	32.13	93.10	100.00	9.41	32.13	60.98	6.90
956E 150	4.3	2.00	5.32	11.08	23.89	32.02	90.62	100.00	1.50	32.02	58.60	9.38
956E 160	4.4	1.58	4.84	13.19	24.86	31.99	90.97	100.00	1.20	31.99	58.98	9.03
956E 170	3.6	2.32	7.20	13.98	28.01	36.09	90.50	100.00	1.40	36.09	54.42	9.50
956E 200	2.9	2.40	7.15	16.36	31.68	38.93	90.30	100.00	6.90	38.93	51.37	9.70
956E 210	3.5	2.52	7.99	15.93	29.84	36.61	90.12	100.00	1.91	36.61	53.51	9.88
956E 220	2.9	1.94	5.85	14.68	30.18	37.35	89.55	100.00	2.60	37.35	52.20	10.45
956E 233	3.8	1.90	6.48	14.18	28.87	36.42	95.12	100.00	0.55	36.42	58.70	4.88
956E 240	4.4	2.34	6.64	14.11	29.42	36.91	88.70	100.00	1.51	36.91	51.78	11.30

Hole/Depth		CaCO3	- - - - - - - - - - Cumulative - Percentages - - - - - - - - - -									
		Equiv.	- - - - Sand (Sieve intervals) - - - - - -					%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
			10-20	10-40	10-60	10-140	10-230						
956E	250	2.6	2.80	8.75	17.35	33.05	40.32	92.69	100.00	0.81	40.32	52.37	7.31
956E	260	2.2	6.62	13.73	23.07	38.52	45.26	92.03	100.00	2.39	45.26	46.77	7.97
956E	270	2.2	3.08	9.47	19.24	35.25	42.93	91.96	100.00	1.18	42.93	49.03	8.04
956E	280	2.5	2.70	8.65	16.77	34.16	42.59	91.69	100.00	2.00	42.59	49.10	8.31
956E	290	2.2	2.48	7.72	15.45	27.90	33.44	92.29	100.00	1.59	33.44	58.85	7.71
956E	300	2.1	2.20	7.91	16.52	32.41	39.11	78.76	100.00	1.00	39.11	39.65	21.24
957E	20	6.9	2.30	7.26	15.55	29.82	36.39	82.40	100.00	0.71	36.39	46.01	17.60
957E	30	6.4	2.28	6.97	12.74	25.75	31.52	84.42	100.00	0.50	31.52	52.90	15.58
957E	40	5.2	3.08	8.22	13.10	24.14	26.63	80.19	100.00	3.41	26.63	53.56	19.81
957E	50	3.8	2.45	9.04	18.74	36.69	45.38	95.29	100.00	1.37	45.38	49.92	4.71
957E	60	0.3	2.44	8.12	17.71	35.09	42.54	95.36	100.00	0.58	42.54	52.82	4.64
957E	70	1.0	1.98	6.86	15.88	30.56	38.37	92.66	100.00	2.25	38.37	54.29	7.34
957E	80	2.6	1.20	4.74	9.82	25.44	35.42	84.36	100.00	0.41	35.42	48.94	15.64
958E	10	4.8	2.91	8.21	16.85	28.85	34.42	81.79	100.00	2.81	34.42	47.37	18.21
958E	20	2.9	0.88	3.34	8.11	16.27	21.22	81.81	100.00	0.69	21.22	60.60	18.19
958E	30	3.6	1.31	4.53	11.49	19.93	23.44	76.72	100.00	0.21	23.44	53.29	23.28
958E	40	4.6	0.41	1.24	1.37	5.81	10.42	79.29	100.00	0.10	10.42	68.87	20.71
958E	50	5.1	2.10	6.10	13.57	27.59	30.21	82.75	100.00	0.71	30.21	52.55	17.25
958E	57	6.9	0.45	2.17	16.77	45.38	57.05	87.88	100.00	0.12	57.05	30.83	12.12

APPENDIX 3

Grain lithology and bulk chemical analyses for all analyzed samples.

Samples are identified by drill hole number and depth in feet.

Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
434E	5	0.0	23.3	4.7	0.0	72.0	0.19	0.81	7.43	33.58	2.05	3.08	0.41	3.57
434E	10	0.0	47.5	1.0	0.5	51.0	0.15	0.87	7.41	33.64	2.11	2.72	0.39	3.89
434E	15	0.0	48.5	5.0	1.0	45.5	0.14	0.87	7.41	33.37	2.16	2.94	0.44	4.02
434E	20	0.0	52.5	0.5	1.0	46.0	0.09	1.01	7.52	33.35	2.12	2.86	0.43	3.76
434E	25	0.0	51.0	4.0	3.0	42.0	0.0	0.78	7.78	33.08	2.14	2.80	0.45	4.34
434E	30	1.7	52.2	5.2	1.7	39.2	0.0	1.03	7.36	33.27	2.21	3.23	0.39	3.91
434E	35	3.5	73.0	3.5	3.0	17.0	0.0	0.64	7.76	33.05	2.13	3.36	0.35	4.15
434E	45	4.0	71.5	3.5	2.0	19.0	0.11	0.98	7.37	33.31	2.14	3.10	0.44	3.91
434E	50	1.0	73.0	1.0	1.0	24.0	0.0	1.20	7.30	33.32	2.15	3.01	0.43	3.55
434E	55	1.0	64.0	2.0	0.0	33.0	0.31	0.69	6.67	34.76	1.93	2.39	0.41	3.72
434E	60	0.0	46.5	16.5	0.0	37.0	0.0	0.51	7.19	35.17	2.01	1.52	0.54	3.54
434E	135	4.2	42.3	4.2	2.1	47.1	0.50	0.66	6.94	34.62	2.09	2.19	0.43	3.32
434E	140	2.6	35.9	5.1	13.8	42.6	0.39	0.85	7.37	33.24	2.18	3.04	0.49	3.72
434E	145	5.8	41.1	4.2	1.6	47.4	0.16	0.75	7.85	33.29	2.01	3.01	0.41	3.76
434E	150	0.5	22.7	5.3	4.3	67.1	0.0	0.84	7.47	33.23	2.00	3.23	0.54	3.89
434E	155	2.5	62.9	6.6	1.5	26.4	0.0	0.85	7.53	33.18	2.08	3.26	0.40	4.10
435E	10	7.8	51.0	2.9	1.5	36.9	0.0	0.61	7.65	33.94	2.29	2.21	0.37	3.85
435E	20	0.0	51.6	2.8	2.0	43.7	0.32	1.07	7.67	33.16	2.32	2.79	0.41	3.63
435E	30	0.0	57.1	3.0	3.6	36.3	0.16	0.71	7.77	33.26	2.21	2.49	0.42	4.15
435E	40	0.0	53.0	4.6	2.7	39.7	0.14	1.08	7.61	32.71	2.15	3.45	0.49	3.95
435E	50	4.0	67.2	8.1	1.5	19.2	0.86	1.42	7.63	32.51	2.14	3.18	0.46	3.42
435E	55	1.0	43.4	4.9	3.9	46.8	0.15	0.99	7.64	32.90	2.31	3.20	0.48	3.83
435E	60	0.4	39.6	2.6	6.5	50.9	0.40	0.95	6.85	33.97	2.22	2.99	0.43	3.24

Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
435E	70	1.5	74.9	5.5	1.5	16.6	0.0	0.74	6.98	34.84	2.11	2.41	0.35	3.30
435E	80	2.0	77.0	3.5	2.0	15.5	0.65	0.74	7.53	33.26	2.39	2.51	0.50	3.84
435E	90	2.9	66.0	1.4	1.4	28.2	0.15	0.61	7.66	33.85	2.07	2.16	0.46	4.09
435E	100	7.1	38.4	2.0	8.1	44.4	0.51	0.81	7.61	33.60	2.30	2.04	0.51	3.64
435E	110	2.1	45.8	1.6	10.9	39.6	0.99	0.78	7.78	33.02	2.35	2.32	0.47	3.75
435E	120	3.8	34.9	3.2	5.9	52.2	0.65	0.72	7.70	33.69	2.22	1.85	0.43	3.87
435E	130	5.5	60.8	2.0	0.5	31.2	0.19	0.61	7.57	34.26	2.12	1.72	0.48	3.90
435E	140	25.9	43.4	1.0	0.0	29.8	0.42	0.65	7.56	34.16	2.02	1.60	0.55	3.92
435E	160	5.2	65.5	3.6	1.5	24.2	0.53	0.54	7.36	34.19	2.20	1.69	0.52	3.97
435E	170	6.0	46.3	1.5	1.0	45.3	0.0	0.41	7.37	34.67	1.90	1.82	0.43	4.11
435E	172	7.0	50.5	3.5	1.0	38.0	0.11	0.51	7.28	34.72	1.90	1.78	0.50	3.89
435E	180	5.7	31.4	3.6	3.1	56.2	0.0	0.51	7.64	33.96	1.97	1.76	0.68	4.22
435E	190	6.0	33.7	2.5	11.1	46.7	0.0	0.42	7.36	34.77	1.92	1.62	0.48	4.08
435E	200	4.5	42.0	2.0	8.5	43.0	0.0	0.58	7.08	34.66	1.75	2.58	0.39	3.72
435E	210	1.5	37.4	1.5	4.6	54.9	0.0	0.83	8.00	32.77	2.04	2.63	0.46	4.56
435E	220	3.6	42.7	4.1	4.5	45.0	0.0	0.60	8.47	33.63	1.91	1.70	0.44	3.97
435E	250	4.3	34.6	4.7	1.9	54.5	0.0	0.60	8.58	32.65	2.09	1.82	0.52	4.76
435E	252	1.6	37.5	5.2	3.1	52.6	0.0	0.71	8.59	32.72	2.01	2.02	0.55	4.48
435E	260	2.5	32.5	3.5	4.0	57.5	0.0	0.66	8.41	32.94	2.04	2.25	0.52	4.41
435E	270	0.0	27.3	0.0	4.5	68.2	0.35	0.75	9.19	31.80	2.03	1.99	0.39	5.08
435E	290	2.5	29.4	1.5	14.7	52.0	0.0	0.67	7.54	33.94	1.94	2.76	0.54	3.58
435E	310	2.6	26.1	1.7	43.5	26.1	0.28	0.85	8.22	32.77	1.78	2.60	0.47	4.36
435E	320	4.8	27.5	4.8	29.5	33.3	0.0	0.66	8.27	32.82	1.90	2.58	0.46	4.64
435E	330	1.5	48.8	0.0	41.8	8.0	0.37	0.64	8.49	32.63	2.01	2.39	0.48	4.40
435E	340	4.5	33.8	10.4	5.0	46.3	0.27	0.84	8.31	32.51	1.89	2.55	0.45	4.64

Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
435E	345	4.6	34.7	4.6	4.6	51.5	0.0	0.63	8.32	32.95	1.86	2.61	0.53	4.32
436E	10	5.3	74.7	4.7	3.2	12.1	0.0	0.68	7.74	33.41	1.92	2.50	0.49	4.46
436E	20	7.2	46.2	3.8	6.7	36.1	0.23	0.95	7.62	33.52	1.79	2.64	0.46	3.90
436E	30	11.1	51.0	4.3	4.3	29.3	0.11	0.90	7.51	33.57	1.78	2.68	0.44	4.05
436E	40	2.5	46.8	3.9	3.0	43.8	0.17	1.11	7.74	32.69	1.82	3.56	0.39	4.02
436E	50	1.0	72.2	1.0	1.0	24.7	0.23	1.07	7.56	33.20	1.91	3.23	0.41	3.61
436E	60	0.5	54.5	1.9	4.8	38.3	0.28	1.20	7.27	33.61	1.92	3.06	0.39	3.37
436E	70	2.0	39.6	3.0	4.6	50.8	0.0	1.02	7.43	33.51	1.98	2.96	0.43	3.86
435E	80	3.3	30.9	0.0	2.8	63.0	0.20	1.15	7.43	33.42	1.90	2.97	0.45	3.70
436E	85	2.1	50.3	2.1	3.7	41.9	0.37	1.10	7.63	32.25	1.77	3.58	0.50	3.43
435E	90	1.5	45.5	0.0	3.5	49.5	0.18	0.76	8.34	32.81	1.72	2.65	0.50	4.31
436E	95	0.5	38.4	3.4	7.4	50.2	0.0	0.68	7.94	33.46	1.84	2.52	0.49	4.15
436E	100	2.5	49.7	5.0	0.5	42.2	0.55	1.11	8.56	31.49	1.69	3.72	0.49	4.23
435E	110	2.0	36.5	6.9	1.5	53.2	0.15	0.87	7.77	33.49	1.82	2.60	0.46	3.94
436E	130	2.5	33.5	19.8	3.0	41.1	0.0	0.97	7.82	33.47	1.76	2.45	0.62	3.87
436E	150	2.5	38.0	3.5	0.5	55.5	0.30	1.08	7.50	33.18	2.01	3.03	0.37	3.90
436E	195	18.9	38.8	5.0	0.0	37.3	0.0	0.86	7.23	33.84	1.92	3.06	0.42	3.80
437E	5	7.0	57.3	3.0	4.0	28.6	0.22	0.89	7.42	33.41	1.97	3.14	0.42	3.83
437E	35	5.5	53.5	3.5	2.5	35.0	0.16	0.87	7.47	33.28	1.96	3.15	0.46	3.99
437E	45	5.7	66.8	2.4	3.3	21.8	0.39	0.98	7.48	33.43	1.86	2.92	0.44	3.73
437E	55	5.6	36.3	1.4	6.5	50.2	0.18	1.05	7.89	32.63	1.88	3.49	0.41	3.97
437E	65	11.5	41.0	4.6	7.8	35.0	0.0	0.99	7.18	34.11	1.90	2.88	0.47	3.44
437E	75	2.5	52.2	6.4	6.9	32.0	0.0	0.53	7.66	34.08	1.82	2.20	0.49	4.10

Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
437E	85	2.5	49.5	3.0	0.5	44.5	0.0	0.72	8.25	33.39	1.79	2.31	0.53	4.00
437E	95	6.0	44.8	3.5	0.5	45.3	0.0	0.71	7.67	34.04	1.72	2.22	0.51	3.98
437E	105	11.3	48.0	3.9	2.0	34.8	0.0	0.61	7.45	34.10	1.86	2.10	0.50	4.31
437E	117	4.9	49.5	4.4	0.5	40.7	0.20	0.73	7.96	33.24	1.68	2.70	0.48	4.19
437E	125	11.0	41.0	5.0	2.0	41.0	0.13	0.73	7.79	33.53	1.72	2.36	0.49	4.32
437E	140	1.4	40.4	5.8	0.0	52.4	0.0	0.56	7.58	34.28	1.80	1.87	0.45	4.27
437E	150	3.5	44.6	5.0	0.0	47.0	0.10	0.97	7.17	34.07	1.73	2.78	0.44	3.71
437E	160	2.0	42.9	5.4	0.0	49.8	0.17	0.88	7.55	33.54	1.81	2.74	0.49	3.95
437E	170	1.5	35.1	3.9	27.3	32.2	0.44	1.07	7.72	32.86	2.02	2.99	0.49	3.78
437E	180	4.7	37.3	3.3	12.3	42.5	0.23	0.71	8.22	32.87	1.79	2.78	0.50	4.18
437E	190	3.0	45.5	7.5	1.5	42.5	0.55	0.68	7.88	33.25	1.94	2.21	0.50	4.15
437E	200	5.0	18.5	8.5	42.5	25.5	0.0	0.38	7.42	34.82	1.98	1.43	0.52	4.07
437E	210	4.5	39.8	3.5	13.4	38.8	0.89	1.16	7.39	32.22	2.32	3.86	0.42	3.69
437E	232	17.6	29.0	5.2	17.6	30.6	0.56	1.36	7.45	32.40	2.38	3.72	0.39	3.55
437E	240	3.5	39.2	1.5	7.5	48.2	0.0	0.44	7.87	33.56	2.01	2.20	0.52	4.31
437E	260	0.5	15.9	0.5	47.5	35.4	0.74	0.70	7.93	32.76	2.03	2.58	0.53	4.07
439E	5	1.4	40.9	0.9	9.8	47.0	0.59	1.12	6.76	33.56	1.91	3.82	0.42	3.13
439E	10	2.0	33.5	2.0	5.9	56.7	0.34	0.78	7.85	33.00	1.96	2.72	0.47	4.06
439E	20	4.5	38.5	5.5	1.0	50.5	0.45	0.83	7.58	33.19	2.06	2.82	0.42	4.03
439E	30	8.8	31.2	3.9	4.4	51.7	0.58	0.86	8.32	31.89	2.01	3.13	0.52	4.47
439E	40	3.4	40.4	1.0	3.0	52.2	0.51	0.96	7.83	33.08	2.25	2.79	0.41	3.50
439E	50	5.0	33.7	5.0	6.0	50.3	0.67	1.11	7.62	32.18	2.03	3.59	0.43	4.22
439E	60	1.5	42.1	3.0	4.0	49.5	0.78	1.13	7.49	32.13	2.45	3.49	0.47	4.08
439E	70	2.2	38.5	3.8	4.9	50.5	0.84	0.95	7.56	32.98	2.53	2.74	0.34	3.64

Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
439E	80	0.9	41.7	1.4	4.7	51.2	1.40	1.03	7.35	31.94	2.63	3.06	0.49	4.01
439E	90	3.3	43.6	4.7	4.7	43.6	1.74	0.87	7.60	31.93	2.81	2.81	0.36	3.78
439E	100	5.0	59.9	1.5	2.0	31.7	0.78	1.02	7.31	31.75	2.54	4.79	0.46	3.56
439E	108	3.0	39.8	1.5	31.8	23.9	0.91	0.97	7.50	32.71	2.76	2.66	0.43	3.78
439E	118	3.4	51.2	2.5	5.9	36.9	0.71	0.55	8.38	33.47	2.34	1.30	0.35	3.96
440E	10	1.5	62.6	2.0	1.5	32.3	0.32	0.74	6.01	35.53	1.90	2.79	0.39	3.06
440E	20	7.5	39.8	4.5	2.0	46.3	1.05	0.76	7.50	33.33	2.47	2.15	0.37	3.73
440E	30	5.1	41.1	2.0	6.1	45.7	1.18	0.83	7.56	32.96	2.38	2.31	0.38	3.89
440E	40	4.4	37.6	2.0	7.3	48.8	1.48	0.75	7.73	32.20	2.67	2.41	0.43	4.15
440E	50	3.8	33.2	4.8	8.7	49.5	0.37	1.02	7.11	33.40	2.30	3.20	0.35	3.69
440E	60	1.4	50.2	0.9	5.5	42.0	0.63	0.62	7.83	33.91	2.13	1.90	0.46	3.47
440E	70	3.4	44.7	1.5	3.9	46.6	1.09	0.73	8.08	33.35	2.10	1.59	0.38	3.76
440E	80	7.8	36.6	4.9	2.0	48.8	0.78	0.74	7.73	33.32	2.14	2.10	0.43	3.94
440E	90	3.3	42.5	2.8	0.5	50.9	1.88	0.71	8.07	32.00	2.49	2.03	0.47	4.11
440E	100	7.8	33.0	3.9	1.0	54.4	0.70	0.54	8.80	33.21	2.22	1.59	0.41	3.55
440E	110	7.5	31.8	0.0	3.7	57.0	0.64	0.72	7.95	33.17	2.30	2.19	0.46	3.80
440E	120	11.6	29.5	0.5	3.7	54.7	0.97	0.65	7.98	33.13	2.18	1.49	0.51	4.41
440E	150	7.1	45.3	2.8	0.5	44.3	0.86	0.41	7.72	33.73	2.30	1.78	0.45	3.92
440E	170	19.2	21.2	3.0	0.0	56.6	0.98	0.42	7.40	34.07	2.24	1.50	0.46	4.03
440E	180	15.4	30.0	2.4	1.2	51.0	1.49	0.54	7.64	33.13	2.61	1.43	0.51	4.06
440E	190	18.4	35.9	1.9	1.9	41.7	1.43	0.63	7.91	32.71	2.47	1.65	0.51	4.12
440E	210	12.6	32.3	0.0	0.4	54.7	1.15	0.65	7.86	32.66	2.25	2.27	0.43	4.20
440E	219	13.1	28.3	0.0	1.0	57.6	0.0	0.47	7.35	35.10	1.82	1.46	0.47	3.79
440E	230	10.1	28.5	1.8	5.7	53.9	1.77	0.69	8.15	31.57	2.69	2.17	0.47	4.51

Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
440E	240	4.7	44.3	2.6	5.2	43.2	0.12	0.69	7.75	33.77	1.85	2.29	0.46	4.07
443E	250	8.3	42.2	2.9	5.3	41.3	0.87	0.43	8.32	33.38	2.14	1.65	0.48	3.85
440E	256	7.6	32.2	1.4	5.7	53.1	1.50	0.77	8.31	31.20	2.74	2.23	0.48	4.69
455E	5	4.2	34.9	0.0	19.1	41.9	0.60	0.57	7.32	34.67	2.03	1.56	0.45	3.53
455E	10	4.3	73.5	3.7	3.7	14.8	1.23	0.77	7.77	32.53	2.71	1.71	0.40	4.50
455E	15	6.2	66.4	2.7	0.9	23.9	1.09	0.88	7.83	33.23	2.33	2.14	0.41	3.34
455E	20	7.3	41.7	1.0	5.7	44.3	1.31	0.94	8.09	32.21	2.59	2.16	0.50	3.82
455E	35	1.9	31.5	2.8	20.4	43.5	1.12	1.85	7.50	31.10	2.62	4.23	0.32	3.58
455E	50	2.4	62.3	9.0	1.4	25.0	1.21	1.34	7.55	32.06	2.64	3.18	0.34	3.69
455E	65	2.0	75.0	6.5	1.0	15.5	2.01	1.95	8.04	29.13	3.01	4.60	0.37	4.03
455E	80	20.3	55.0	7.9	2.0	14.9	0.24	1.93	7.17	31.48	2.19	5.16	0.35	3.72
455E	95	7.3	49.7	2.6	1.6	38.9	2.29	1.44	7.80	30.10	3.18	3.62	0.36	4.01
455E	110	6.6	54.3	5.6	2.5	31.0	0.49	1.58	8.31	31.16	2.14	3.58	0.41	4.31
456E	5	1.4	44.6	1.4	16.2	36.5	0.0	0.68	7.66	33.96	1.99	2.01	0.45	4.19
456E	15	23.5	41.2	0.0	0.0	35.3	0.26	0.87	7.75	33.02	2.12	2.39	0.54	4.45
456E	25	0.0	38.7	0.0	11.7	49.5	0.0	0.66	7.43	34.08	1.92	2.12	0.45	4.16
456E	35	5.3	43.8	0.0	10.1	40.8	0.0	0.72	7.55	33.79	2.00	2.41	0.38	4.24
456E	40	12.5	59.0	4.0	2.5	22.0	0.0	0.58	8.01	33.97	1.83	2.01	0.47	3.93
456E	45	6.9	49.8	6.9	5.4	31.0	0.0	0.52	6.88	35.24	1.88	2.26	0.32	3.48
456E	55	22.2	47.7	6.8	1.7	21.6	0.0	1.00	8.25	32.56	2.18	2.63	0.42	4.43
456E	65	21.0	56.5	4.5	1.5	16.5	0.0	1.07	8.77	32.24	2.07	2.41	0.41	4.48
456E	75	12.2	55.8	3.4	3.4	25.2	0.62	1.35	7.81	32.24	2.20	3.27	0.39	3.87
456E	85	5.0	80.5	2.5	2.0	10.0	0.25	1.03	7.90	32.91	2.12	2.77	0.43	3.98

Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
456E	95	0.7	54.9	4.6	2.6	37.3	0.0	1.09	8.35	32.69	2.10	2.48	0.49	4.13
456E	120	0.0	72.2	2.6	2.1	23.2	0.54	2.29	7.25	30.47	2.19	5.58	0.44	3.91
456E	125	0.0	79.5	4.0	1.0	15.5	0.71	2.31	7.02	30.57	2.14	5.68	0.47	3.81
456E	130	0.5	35.7	1.0	4.8	58.0	0.22	0.66	7.36	34.04	2.01	2.35	0.47	3.90
456E	135	2.0	62.0	5.5	1.5	29.0	0.51	0.63	6.70	34.67	1.87	2.20	0.49	3.65
456E	145	0.8	40.6	3.1	0.8	54.7	0.0	0.28	7.62	34.85	1.89	1.37	0.43	4.12
456E	150	4.0	61.5	2.5	1.0	31.0	0.25	0.42	7.67	34.32	2.09	1.42	0.42	4.23
457E	10	1.0	80.5	1.5	1.0	16.0	0.77	1.14	6.52	33.94	1.99	3.23	0.36	3.36
457E	30	12.7	58.8	4.9	1.0	22.5	0.61	1.28	6.87	33.15	2.07	3.56	0.40	3.63
457E	50	0.0	65.1	5.3	0.6	29.0	0.50	1.22	7.32	32.84	2.09	3.43	0.36	3.85
457E	60	0.5	75.5	9.0	3.5	11.5	0.48	2.36	6.64	30.84	2.07	6.03	0.37	3.81
457E	70	0.0	67.3	1.5	2.0	29.2	0.72	2.38	6.43	31.15	2.04	6.07	0.37	3.43
457E	87	5.1	50.0	10.1	14.1	20.7	0.52	1.88	6.54	31.88	2.08	5.47	0.43	3.45
457E	100	0.5	62.6	4.4	1.9	30.6	0.0	1.12	7.48	32.82	2.37	3.32	0.41	4.06
457E	110	6.0	74.5	1.0	4.0	14.5	0.0	0.51	6.20	35.53	1.95	2.75	0.42	3.30
457E	120	5.6	56.1	2.3	3.7	32.2	0.26	0.59	8.86	33.14	1.77	2.18	0.54	3.58
457E	130	5.0	69.0	4.5	3.0	18.5	0.13	1.18	7.27	32.99	2.21	3.28	0.40	4.10
457E	185	1.0	48.8	2.5	1.5	46.3	0.43	1.03	7.32	33.01	2.07	3.14	0.46	4.07
457E	200	0.0	64.5	4.4	3.4	27.6	0.18	1.14	7.41	33.13	2.06	3.09	0.36	4.05
457E	210	12.5	61.5	8.5	1.5	16.0	0.64	2.06	6.78	32.06	1.97	4.96	0.38	3.18
457E	240	1.0	62.0	1.0	1.0	35.0	0.44	1.57	7.00	32.32	2.10	4.38	0.40	3.71
458E	15	0.0	56.5	1.0	24.5	18.0	0.43	1.51	7.61	31.52	2.23	4.27	0.39	4.21
458E	25	1.5	66.5	1.0	9.5	21.5	0.39	0.85	7.72	33.24	1.93	2.58	0.57	3.97

Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
458E	80	6.0	66.7	2.5	1.5	23.4	0.14	0.97	7.43	33.07	2.10	3.31	0.47	3.98
458E	185	1.0	49.8	3.5	8.5	37.3	0.27	0.61	7.16	34.11	2.02	2.47	0.40	4.03
458E	225	0.5	65.5	3.9	6.4	23.6	0.67	0.96	7.01	33.94	1.92	2.74	0.42	3.48
458E	235	1.0	51.0	5.2	3.1	39.6	0.28	0.86	5.95	35.15	1.82	2.75	0.46	3.57
458E	255	3.0	68.0	1.5	7.4	20.2	0.47	0.85	8.28	32.14	4.93	2.56	0.25	2.64
459E	10	1.5	58.7	3.0	6.5	30.3	0.21	1.44	7.65	32.66	2.09	3.08	0.46	3.91
459E	40	1.0	73.6	1.0	0.0	24.4	0.36	1.36	7.53	32.44	2.17	3.41	0.33	3.97
459E	60	0.7	71.9	7.9	0.0	19.4	0.38	1.28	6.80	33.76	2.00	3.10	0.41	3.53
459E	70	1.0	68.0	2.5	8.9	19.7	0.31	2.42	6.79	31.10	2.07	5.96	0.38	3.44
459E	100	1.0	70.4	3.0	4.5	21.1	0.74	1.55	7.94	30.93	2.17	3.82	0.47	4.72
461E	5	1.0	56.3	2.0	2.5	38.1	0.76	0.83	6.77	33.75	1.93	2.49	0.43	4.40
461E	10	5.5	70.0	2.0	1.5	21.0	0.42	0.80	8.01	33.16	2.02	2.15	0.45	4.23
461E	15	7.5	71.5	1.5	2.5	17.0	0.12	0.84	7.54	34.00	1.98	2.18	0.43	3.85
461E	20	0.0	59.0	6.5	4.0	30.5	0.17	0.80	7.43	34.06	1.97	2.19	0.45	3.88
461E	25	21.0	57.5	10.0	0.5	11.0	0.45	0.92	7.57	33.52	2.05	2.34	0.39	3.96
461E	30	2.4	52.4	1.6	17.5	26.2	0.0	0.77	7.50	33.99	1.97	2.21	0.40	3.94
461E	35	1.8	71.6	3.0	3.0	20.7	0.30	0.93	8.12	32.56	2.06	2.56	0.56	4.39
461E	40	1.2	56.5	4.3	12.4	25.5	0.0	0.78	8.13	32.77	2.18	2.57	0.48	4.51
461E	45	19.5	53.5	4.0	1.0	22.0	0.40	0.80	7.88	33.25	1.97	2.44	0.45	3.86
461E	50	7.0	61.1	7.0	2.7	22.2	0.0	0.69	7.37	34.17	1.96	2.19	0.45	4.09
461E	65	5.5	67.0	3.0	3.0	21.5	0.34	0.88	7.59	33.35	2.01	2.46	0.54	4.09
461E	69	1.0	54.7	4.4	4.4	35.5	0.30	0.80	7.01	34.11	2.01	2.48	0.44	3.95
461E	75	2.0	67.0	5.5	1.0	24.5	0.32	0.75	7.22	34.59	1.89	2.00	0.41	3.56

Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
462E	5	0.0	47.9	1.4	8.6	42.1	0.35	0.65	7.29	35.10	1.82	1.44	0.39	3.43
462E	20	1.6	50.8	3.1	7.3	37.2	0.0	0.87	7.59	33.76	2.09	2.28	0.43	4.05
462E	35	2.4	29.3	6.1	25.6	36.6	0.12	0.84	7.70	33.64	1.90	2.33	0.43	4.11
462E	50	0.0	55.4	5.9	14.9	23.8	0.43	2.41	7.04	30.76	2.13	5.70	0.41	3.70
462E	60	5.5	75.5	3.0	4.0	12.0	0.37	1.47	8.12	31.48	2.17	3.89	0.36	4.16
462E	75	1.0	61.9	2.5	8.4	26.2	0.0	1.97	7.60	31.14	2.26	4.67	0.39	4.13
462E	90	10.5	58.5	4.5	6.5	20.0	0.23	1.31	8.41	31.41	2.10	3.58	0.46	4.33
463E	10	1.0	45.5	11.5	12.0	30.0	0.0	0.71	7.57	33.84	1.95	2.16	0.49	4.29
463E	20	5.5	71.5	3.5	4.5	15.0	0.0	0.46	6.82	36.10	1.66	1.42	0.35	3.31
463E	25	14.9	47.5	4.0	5.0	28.7	0.90	0.59	7.78	33.00	2.25	2.06	0.49	4.33
463E	30	11.0	69.1	3.7	1.5	14.7	0.33	0.74	7.69	33.86	1.96	2.05	0.34	4.02
463E	40	29.5	39.0	3.5	4.0	24.0	0.12	0.98	8.59	32.18	2.05	2.55	0.40	4.65
463E	50	10.0	65.5	4.0	0.5	20.0	0.11	0.84	7.73	33.48	2.02	2.29	0.50	4.18
463E	60	0.5	56.3	2.2	7.7	33.3	0.34	0.91	7.50	33.61	1.92	2.42	0.50	3.93
463E	70	16.0	59.0	3.5	3.5	18.0	0.0	0.90	7.68	33.67	2.06	2.31	0.45	4.01
463E	75	28.0	55.5	3.5	1.0	12.0	0.52	0.95	8.56	32.00	2.24	2.36	0.43	4.61
463E	80	0.0	44.8	2.0	32.3	20.9	1.24	0.75	7.32	33.21	1.86	2.44	0.43	4.23
463E	85	5.0	74.0	3.0	4.0	14.0	0.21	0.79	7.09	34.15	1.98	2.26	0.50	4.04
463E	90	4.0	71.5	3.5	2.5	18.5	0.40	0.91	7.88	33.16	2.04	2.26	0.50	4.02
463E	95	2.0	63.0	9.0	2.0	24.0	0.24	0.90	7.62	33.30	2.06	2.55	0.42	4.22
463E	100	0.0	50.0	5.2	19.0	25.8	0.43	1.00	8.07	32.49	2.17	2.46	0.48	4.35
496E	210	0.0	41.9	5.6	17.9	34.6	0.41	0.89	7.90	32.53	1.98	2.69	0.56	4.48

Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
496E	250	2.5	45.7	1.5	5.5	44.7	0.0	0.58	7.38	34.67	1.93	1.35	0.51	4.08
496E	290	11.9	51.5	1.0	3.5	32.2	0.12	0.18	6.77	35.89	1.96	1.05	0.49	3.87
496E	310	3.1	53.1	4.1	3.6	36.2	0.0	0.13	8.21	35.09	1.76	1.00	0.35	3.71
496E	330	1.6	53.3	3.3	5.7	36.1	0.11	0.27	7.08	35.53	1.87	1.14	0.52	3.85
496E	345	4.7	66.8	3.2	1.6	23.7	0.0	0.45	7.39	34.82	1.71	1.39	0.53	4.10
496E	365	21.3	30.2	11.4	3.0	34.2	0.35	0.63	7.66	33.92	1.75	1.85	0.51	4.28
497E	30	1.0	61.8	4.0	8.5	24.6	0.46	1.61	7.86	31.18	2.18	4.23	0.44	4.24
497E	40	5.5	68.5	3.5	5.5	17.0	0.28	1.57	7.73	31.74	2.23	3.98	0.47	3.97
497E	50	18.5	45.5	8.0	5.5	22.5	0.23	1.20	7.44	33.18	2.10	3.15	0.35	3.72
497E	80	11.9	54.7	5.0	3.0	25.4	0.21	1.03	8.13	32.80	1.95	2.49	0.49	4.23
497E	90	25.5	48.0	1.0	1.5	24.0	0.25	0.53	8.39	32.78	1.91	2.16	0.48	4.85
497E	100	30.8	40.3	4.0	4.0	20.9	0.58	0.76	7.78	33.42	1.87	2.54	0.40	3.83
497E	110	11.5	59.5	3.0	1.0	25.0	0.12	0.84	8.05	33.08	1.99	2.54	0.45	4.18
497E	120	60.5	26.0	1.0	2.5	10.0	0.17	1.21	7.91	32.54	2.07	3.03	0.41	4.22
497E	130	0.0	69.0	6.5	1.5	23.0	0.34	1.86	7.91	30.16	2.26	4.92	0.44	4.83
497E	140	3.0	60.7	3.0	12.4	20.9	0.21	1.87	7.84	31.17	2.23	4.00	0.40	4.21
497E	150	3.0	67.5	6.0	2.5	21.0	0.56	1.86	7.46	31.21	2.10	4.64	0.34	4.15
497E	160	6.5	55.7	5.0	8.0	24.9	0.0	1.63	7.73	31.22	2.23	4.56	0.44	4.29
497E	170	2.3	69.4	1.2	1.7	25.4	0.40	1.93	7.59	31.45	2.12	4.44	0.38	3.69
497E	220	1.0	65.0	5.0	1.5	27.5	0.21	1.06	8.74	31.65	2.19	2.77	0.47	4.68
497E	230	4.5	63.5	6.5	5.0	20.5	0.29	1.23	8.92	31.40	2.20	2.89	0.48	4.38
497E	240	0.7	61.5	2.2	7.4	28.1	0.17	1.20	10.02	29.81	1.49	3.83	0.46	5.09
497E	250	6.5	64.5	6.5	2.0	20.5	0.12	0.92	7.38	33.68	1.96	3.00	0.39	3.71
497E	260	0.0	67.0	3.5	3.5	26.0	0.49	1.21	7.57	32.69	2.10	3.04	0.48	4.01

Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
497E	270	2.5	58.0	11.0	3.5	25.0	0.67	1.20	8.07	32.05	2.24	3.15	0.43	3.97
497E	280	2.3	63.6	6.1	6.8	21.2	0.26	1.09	9.14	31.19	2.23	2.61	0.50	4.83
497E	290	1.5	66.0	4.0	2.5	26.0	0.37	1.11	8.35	32.21	2.10	2.67	0.50	4.25
497E	295	2.1	70.8	0.0	4.2	22.9	0.23	1.15	8.03	32.56	2.03	2.89	0.47	4.11
498E	15	3.0	60.0	3.0	5.5	28.5	0.0	0.91	8.11	33.49	1.96	2.30	0.53	3.68
498E	25	2.0	54.5	8.1	6.1	29.3	0.0	0.75	7.93	33.35	1.97	2.53	0.45	4.17
498E	40	1.0	61.0	7.0	4.5	26.5	0.0	0.90	7.65	33.65	2.02	2.46	0.44	3.95
498E	55	9.5	63.5	7.0	3.5	16.5	0.0	0.91	7.69	33.97	1.88	2.29	0.43	3.70
498E	65	11.5	52.5	6.0	4.0	26.0	0.0	0.81	7.69	33.76	1.91	2.20	0.45	4.18
498E	70	1.0	69.5	7.0	1.5	21.0	0.0	0.85	7.78	33.44	1.91	2.55	0.44	4.16
498E	100	0.5	67.5	3.5	8.0	20.5	0.34	1.89	8.32	30.66	2.17	4.18	0.50	4.02
498E	110	3.0	69.5	3.5	2.5	21.5	0.27	1.78	8.21	31.14	2.32	3.49	0.42	4.47
498E	120	5.5	50.5	4.5	14.5	25.0	0.33	1.90	7.82	30.88	2.28	4.40	0.43	4.09
498E	130	5.1	70.1	5.1	2.8	16.9	0.20	1.48	7.88	31.55	2.27	3.83	0.50	4.33
498E	140	3.5	69.0	3.5	4.5	19.5	0.18	1.83	7.90	30.92	2.25	4.59	0.37	4.29
498E	150	0.5	63.0	4.0	8.5	24.0	0.32	1.76	7.63	31.83	2.22	3.96	0.44	3.77
498E	160	17.5	48.0	5.5	3.5	25.5	0.15	0.94	8.01	32.82	1.96	2.85	0.47	4.18
498E	170	6.0	59.5	7.0	7.5	20.0	0.0	1.61	7.85	31.59	2.22	4.01	0.33	4.23
498E	180	1.5	69.0	4.5	5.5	19.5	0.0	1.66	7.98	31.40	2.20	4.15	0.43	4.24
498E	190	1.5	53.0	4.5	19.5	21.5	0.13	1.78	7.77	31.39	2.22	4.16	0.50	3.97
498E	200	1.0	69.5	1.0	4.0	24.5	0.0	2.18	7.48	31.17	2.28	4.89	0.38	3.76
498E	250	0.5	59.0	3.5	9.0	28.0	0.70	1.94	7.33	31.43	2.14	4.56	0.39	3.73
498E	265	1.5	66.0	6.0	0.5	26.0	0.39	1.82	7.91	30.95	2.17	4.19	0.44	4.20
498E	270	4.9	56.4	7.4	4.3	27.0	0.68	1.13	7.53	32.70	2.13	2.94	0.53	3.88

Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
498E	275	0.0	59.0	5.0	3.0	33.0	0.48	1.11	7.22	33.27	1.98	3.06	0.46	3.70
498E	280	4.4	62.2	4.4	2.2	26.7	0.65	0.97	7.27	33.62	1.98	2.80	0.40	3.53
498E	290	0.0	63.5	4.0	5.0	27.5	0.25	0.92	7.48	33.35	2.05	2.87	0.51	3.85
706E	50	6.0	68.5	4.5	3.5	17.5	0.38	1.12	8.21	32.68	1.98	2.98	0.40	3.49
706E	60	3.5	73.0	3.5	1.5	18.5	0.57	1.16	7.91	32.43	1.97	2.81	0.44	4.08
706E	70	4.0	67.5	1.5	2.0	25.0	0.56	1.10	7.75	32.73	1.99	2.91	0.46	3.88
706E	80	5.0	62.5	1.5	5.5	25.5	0.17	0.83	7.95	34.18	1.89	1.61	0.50	3.54
706E	100	3.0	57.0	5.5	2.5	32.0	0.54	1.12	7.03	33.96	1.85	2.87	0.48	3.22
705E	110	1.0	72.5	2.5	4.0	20.0	0.39	0.77	7.91	33.00	4.01	2.54	0.34	2.51
706E	120	6.0	62.5	4.5	4.0	23.0	0.45	1.06	7.77	33.20	1.89	2.84	0.42	3.41
706E	125	2.5	62.0	2.0	4.0	29.5	0.0	0.97	7.29	33.86	1.84	2.86	0.35	3.65
706E	130	0.5	62.0	0.5	7.5	29.5	0.41	1.06	8.42	32.67	2.06	2.82	0.33	3.42
706E	200	0.5	54.0	7.5	6.0	32.0	0.39	1.09	8.06	32.01	2.03	3.35	0.50	4.10
706E	210	2.5	63.5	4.5	2.5	27.0	0.62	1.27	8.81	31.34	2.11	2.67	0.50	4.42
705E	220	4.5	58.5	7.0	4.5	25.5	0.29	1.02	8.17	32.54	1.97	2.50	0.54	4.18
706E	230	7.1	51.5	2.0	5.1	34.3	0.27	0.61	7.50	34.85	1.73	1.34	0.39	3.73
705E	240	4.0	60.0	2.7	1.3	32.0	0.14	0.74	8.39	33.53	2.01	1.77	0.49	3.84
706E	250	9.7	64.6	4.9	2.8	18.1	0.36	0.73	7.53	34.46	1.85	1.62	0.40	3.71
706E	260	53.0	29.0	0.5	3.0	14.5	0.76	0.70	8.01	33.91	1.75	1.93	0.41	3.29
705E	270	8.5	61.0	5.0	3.5	22.0	0.22	0.68	7.34	33.98	1.67	2.58	0.44	3.88
706E	280	14.5	53.5	3.5	2.5	26.0	0.16	0.45	7.51	34.37	1.81	1.78	0.52	4.18
706E	290	6.0	73.0	1.5	1.0	18.5	0.33	0.83	8.26	32.92	1.94	2.01	0.54	4.20
705E	325	8.0	51.0	1.5	9.0	30.5	0.43	0.76	7.91	33.93	1.84	1.73	0.74	3.44
706E	345	45.0	33.6	13.6	1.4	6.4	0.29	0.67	7.16	34.78	1.83	1.67	0.49	3.79

Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
706E	348	10.5	62.0	4.5	1.5	21.5	0.71	0.71	7.04	34.68	1.94	1.62	0.46	3.59
706E	360	6.5	70.5	4.0	2.5	16.5	0.44	0.98	8.22	32.65	1.93	2.17	0.53	4.29
709E	10	1.9	66.9	3.8	4.5	22.9	0.25	1.16	7.77	33.03	2.01	2.81	0.53	3.72
709E	20	3.0	56.5	2.0	8.5	30.0	0.39	1.05	8.17	33.25	2.11	2.32	0.45	3.35
709E	30	1.0	72.0	3.0	2.5	21.5	0.38	0.98	7.30	33.87	1.93	2.53	0.50	3.58
709E	40	3.0	67.5	2.0	6.0	21.5	0.29	1.49	8.19	31.28	2.16	3.94	0.49	4.09
709E	50	1.6	63.7	6.3	5.3	23.2	0.28	1.23	7.55	32.66	1.99	3.31	0.46	3.82
709E	60	0.5	68.0	4.0	4.5	23.0	0.20	1.04	7.51	33.37	2.00	3.04	0.39	3.56
709E	70	2.9	65.7	1.5	3.4	26.5	0.34	1.23	7.55	32.54	2.12	3.42	0.38	3.99
709E	80	0.5	64.0	2.0	8.0	25.5	0.39	1.29	7.63	33.14	2.13	2.92	0.35	3.48
709E	90	0.5	71.0	6.0	4.5	18.0	0.55	1.78	7.74	31.68	2.09	3.65	0.48	3.97
709E	100	1.5	62.9	1.5	3.5	30.7	0.25	0.73	7.23	34.57	1.99	1.76	0.45	3.79
709E	110	1.0	67.5	3.0	3.0	25.5	0.0	0.69	7.74	34.73	1.98	1.62	0.45	3.29
709E	120	1.5	60.0	0.0	3.0	35.5	0.40	0.62	7.73	34.46	2.01	1.72	0.44	3.31
709E	130	2.5	66.5	2.5	2.0	26.5	0.08	0.55	7.10	35.37	1.84	1.63	0.46	3.27
709E	140	2.0	66.0	1.0	4.5	26.5	0.26	0.60	6.49	35.83	1.85	1.85	0.40	3.08
709E	150	2.0	61.0	3.5	3.5	30.0	0.50	0.90	7.65	33.41	2.02	2.02	0.49	3.83
709E	160	5.5	58.0	2.5	5.5	28.5	0.0	0.53	7.93	33.71	1.94	2.13	0.50	4.26
709E	170	4.0	56.5	2.0	2.5	35.0	0.72	0.37	6.93	34.89	1.97	1.68	0.41	3.52
710E	5	1.5	67.5	2.0	3.5	25.5	0.40	1.40	8.06	31.08	2.16	3.93	0.51	4.55
710E	90	6.5	65.6	4.3	3.2	20.4	0.38	0.89	6.80	34.98	1.87	2.22	0.39	3.15
710E	95	4.5	69.5	2.0	4.5	19.5	0.24	1.01	7.40	34.04	1.90	2.50	0.38	3.47
710E	110	2.5	63.0	5.5	5.0	24.0	0.54	1.00	7.70	32.77	1.94	3.26	0.41	3.74

Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
710E	115	1.5	62.5	7.0	2.5	26.5	0.48	1.25	7.83	31.73	2.17	3.65	0.52	4.11
710E	120	1.5	67.5	5.5	2.5	23.0	0.34	0.85	7.63	34.24	1.85	2.20	0.38	3.29
710E	125	2.5	69.0	4.5	2.5	21.5	0.0	0.78	7.70	34.08	1.82	2.58	0.42	3.26
710E	130	2.0	65.5	5.5	4.0	23.0	0.19	0.94	7.86	33.20	1.94	2.93	0.44	3.54
710E	135	2.0	66.7	6.1	6.1	19.2	0.25	0.87	7.55	33.92	1.80	2.50	0.45	3.43
710E	140	2.0	73.5	5.0	2.5	17.0	0.64	1.41	7.43	32.77	2.11	3.19	0.46	3.54
710E	145	0.5	78.0	2.5	2.5	16.5	0.46	0.94	7.58	33.63	2.28	2.35	0.39	3.57
710E	150	2.5	69.5	4.0	2.5	21.5	0.56	1.10	7.53	32.75	1.96	3.11	0.43	3.85
710E	155	1.5	67.0	5.5	1.5	24.5	0.33	1.19	7.65	32.88	2.12	2.84	0.43	3.86
710E	160	0.0	65.5	5.0	4.5	25.0	0.55	1.11	7.56	33.37	1.94	2.62	0.39	3.53
710E	165	2.0	66.5	2.5	3.5	25.5	0.30	0.83	7.67	34.27	2.01	2.11	0.34	3.24
710E	244	2.0	63.0	1.5	5.0	28.5	0.57	1.23	7.51	32.62	2.00	3.18	0.51	3.76
710E	273	9.5	84.1	1.0	3.0	2.5	0.26	1.03	7.89	33.10	1.94	2.72	0.41	3.83
713E	60	16.2	62.2	6.3	2.7	12.6	0.80	0.89	7.86	32.80	2.10	2.64	0.39	4.03
713E	70	12.0	66.0	8.5	4.5	9.0	0.31	0.94	8.62	33.04	1.92	1.50	0.40	4.26
713E	80	1.5	77.5	3.0	2.0	16.0	0.61	1.39	7.65	32.21	2.11	3.11	0.46	4.10
713E	90	13.0	67.5	2.5	3.0	14.0	0.54	1.15	7.29	34.05	1.98	2.54	0.31	3.10
713E	100	1.0	72.5	6.0	1.5	19.0	0.33	0.65	7.69	34.43	1.88	2.11	0.38	3.15
713E	110	1.0	71.0	2.5	4.5	21.0	0.31	0.83	8.04	34.02	1.85	1.99	0.35	3.37
713E	120	0.0	76.0	5.0	1.5	17.5	0.41	1.38	7.01	33.51	1.96	3.25	0.37	3.41
714E	5	5.5	68.5	2.0	6.5	17.5	0.0	1.87	7.55	31.68	2.05	4.64	0.42	3.76
714E	10	0.5	77.0	3.5	2.0	17.0	0.49	1.71	7.83	31.23	2.30	4.52	0.35	3.78
714E	15	0.0	71.5	5.0	4.0	19.5	0.36	2.03	7.52	31.37	2.07	4.74	0.38	3.68

Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
714E	20	3.0	72.5	2.5	3.5	18.5	0.0	1.80	7.87	31.62	2.10	4.44	0.35	3.74
714E	25	4.5	65.5	3.0	8.5	18.5	0.0	1.87	7.36	31.38	2.20	5.25	0.39	3.79
714E	30	7.0	76.0	3.5	3.0	10.5	0.28	1.89	8.02	30.90	2.23	4.35	0.48	4.02
714E	35	1.5	66.5	13.0	3.5	15.5	0.42	1.81	7.75	31.41	2.20	4.40	0.42	3.68
714E	40	0.5	66.5	8.5	2.5	22.0	0.23	1.77	7.69	31.46	2.22	4.49	0.37	3.75
714E	45	3.0	57.5	5.0	7.0	27.5	0.42	1.76	7.88	31.29	2.28	4.47	0.39	3.66
714E	50	6.5	67.0	4.5	3.5	18.5	0.46	2.02	7.62	31.10	2.16	4.67	0.43	3.78
714E	55	3.5	74.0	4.5	5.0	13.0	0.23	1.61	7.99	31.39	2.18	4.40	0.42	3.84
714E	60	0.5	70.5	7.0	3.0	19.0	0.59	2.22	5.91	32.59	1.86	5.42	0.33	2.98
714E	65	2.2	69.8	3.3	3.8	20.9	0.32	1.72	7.96	31.36	2.10	4.17	0.39	3.93
714E	70	3.5	67.5	3.0	8.5	17.5	0.53	1.79	7.61	31.52	2.17	4.33	0.44	3.71
714E	75	3.0	65.5	5.0	2.5	24.0	0.0	1.82	7.81	31.54	2.09	4.40	0.48	3.82
714E	80	1.5	75.5	3.0	4.0	16.0	0.30	1.77	8.04	31.18	2.08	4.45	0.40	3.88
714E	85	1.5	74.5	6.5	3.0	14.5	0.15	2.29	7.26	31.35	2.02	5.18	0.36	3.59
714E	90	5.0	67.0	5.5	8.5	14.0	0.0	1.86	7.73	31.13	2.14	5.02	0.42	3.93
714E	95	0.5	44.5	41.0	2.0	12.0	0.30	1.68	7.66	31.34	2.27	4.47	0.46	3.86
714E	100	2.0	60.5	2.5	2.5	32.5	0.36	1.06	7.43	33.15	2.07	3.17	0.44	3.57
714E	105	3.0	62.5	4.0	3.5	27.0	0.0	0.77	7.02	34.23	2.02	3.01	0.45	3.50
714E	110	4.5	51.5	8.5	5.0	30.5	0.0	1.10	7.57	32.83	2.07	3.36	0.47	3.92
714E	115	13.5	52.0	4.0	3.5	27.0	0.0	0.80	8.45	32.58	2.11	2.56	0.50	4.38
714E	120	4.0	65.0	5.5	4.0	21.5	0.11	0.89	8.42	32.52	2.01	2.66	0.54	3.96
714E	125	4.5	62.5	4.0	2.5	26.5	0.27	0.97	8.46	32.44	1.97	2.81	0.48	4.01
714E	130	5.0	52.0	8.0	6.5	28.5	0.0	0.97	8.48	32.26	1.93	3.23	0.45	4.20
714E	135	2.5	66.5	8.5	0.5	22.0	0.15	0.93	8.39	32.76	1.92	2.70	0.47	3.95
714E	140	8.5	68.0	1.5	5.5	16.5	0.0	0.97	8.76	32.07	1.93	3.00	0.51	4.26

Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
714E	145	9.5	59.0	5.0	4.0	22.5	0.13	0.90	8.77	32.29	1.99	2.79	0.54	3.99
714E	150	4.9	68.6	2.9	5.9	17.6	0.0	0.71	8.56	33.01	1.86	2.61	0.39	3.98
714E	155	7.0	55.5	3.0	7.5	27.0	0.34	0.82	8.43	32.52	2.00	2.85	0.48	3.97
714E	160	5.5	55.0	3.0	2.5	34.0	0.0	0.90	8.31	32.80	1.92	2.84	0.43	4.08
714E	165	1.1	63.8	4.3	3.2	27.7	0.0	0.98	8.27	32.63	2.15	2.90	0.46	4.00
714E	170	16.5	49.0	3.0	0.5	31.0	0.0	0.68	8.38	32.96	2.03	2.25	0.55	4.35
714E	175	6.7	58.1	3.8	3.8	27.6	0.0	0.80	8.32	33.30	1.98	2.01	0.46	4.03
714E	180	9.0	65.0	10.0	2.5	13.5	0.20	0.81	8.48	32.53	1.97	2.59	0.51	4.20
714E	185	6.0	67.5	2.0	1.0	23.5	0.0	0.70	7.93	33.69	1.98	2.06	0.62	3.78
714E	190	2.5	58.5	2.5	1.5	35.0	0.0	0.62	8.19	33.57	1.91	2.22	0.51	3.94
714E	195	1.5	56.5	11.0	0.0	31.0	0.0	0.67	8.17	33.53	1.94	2.26	0.59	3.84
714E	200	2.5	57.0	1.0	2.0	37.5	0.0	0.60	8.43	33.35	1.93	1.93	0.44	4.32
715E	10	4.0	70.0	2.5	3.0	20.5	0.0	1.01	7.65	33.35	2.08	2.63	0.44	4.09
715E	20	2.5	66.5	2.5	5.5	23.0	0.27	0.83	7.39	33.33	2.05	3.22	0.48	3.80
715E	30	2.0	54.5	3.0	4.5	36.0	0.0	0.86	7.00	34.32	2.04	2.75	0.45	3.30
715E	40	2.0	56.5	8.5	5.5	27.5	0.0	0.89	7.59	33.48	1.82	3.33	0.47	3.56
716E	10	2.5	69.0	5.5	5.0	18.0	0.0	0.91	7.53	33.30	1.95	3.32	0.38	3.92
716E	20	26.5	54.0	2.5	2.5	14.5	0.0	0.79	7.78	33.57	2.08	2.14	0.56	4.14
716E	30	48.5	32.5	3.0	1.5	14.5	0.0	1.04	7.79	33.42	2.19	2.58	0.44	3.69
716E	40	1.5	65.5	2.0	4.0	27.0	0.0	0.91	7.55	33.49	2.03	3.12	0.44	3.58
716E	50	1.5	67.0	6.0	3.5	22.0	0.0	1.12	7.62	33.17	2.05	3.01	0.44	3.76
716E	60	2.5	73.0	3.0	2.0	19.5	0.31	1.06	7.52	33.23	2.01	3.07	0.41	3.76
716E	70	0.5	62.5	5.0	5.0	27.0	0.28	1.18	7.50	33.06	2.06	3.12	0.41	3.80

Hole/Depth		CaCO3	- - - - - - - - - - Cumulative - Percentages - - - - - - - - -											
		Equiv.	- - - - Sand (Sieve intervals) - - - - - -					%Sand + Silt	%Sand, Silt & Clay	%Coarser than 10 mesh	%Sand	%Silt	%Clay
			10-20	10-40	10-60	10-140	10-230						
716E	50	7.4	3.33	9.89	22.43	36.30	42.34	91.56	100.00	1.49	42.34	49.22	8.44
716E	60	6.6	3.63	9.89	19.46	34.46	40.52	90.50	100.00	2.12	40.52	49.99	9.50
716E	70	7.4	3.36	11.58	23.06	36.86	42.81	92.49	100.00	1.59	42.81	49.68	7.51
716E	80	6.5	3.67	9.80	19.36	34.28	40.00	85.25	100.00	1.84	40.00	45.26	14.75
716E	90	6.6	3.73	10.05	19.95	33.74	39.79	88.09	100.00	1.10	39.79	48.29	11.91
716E	100	7.7	4.11	11.56	22.06	38.73	45.59	89.17	100.00	2.58	45.59	43.58	10.83
716E	110	7.7	1.78	5.84	18.33	41.53	48.08	88.41	100.00	0.92	48.08	40.32	11.59
716E	120	5.2	2.97	8.15	14.96	26.19	30.86	83.08	100.00	2.34	30.86	52.22	16.92
716E	130	2.6	0.79	2.55	4.61	7.58	9.62	69.28	100.00	0.40	9.62	59.66	30.72
716E	140	4.8	3.03	8.42	15.99	29.11	35.30	90.67	100.00	0.30	35.30	55.38	9.33
716E	150	5.5	3.76	10.39	19.49	32.26	38.13	89.11	100.00	5.54	38.13	50.97	10.89
716E	160	7.3	3.69	10.26	21.03	35.36	41.61	87.52	100.00	3.09	41.61	45.91	12.48
716E	170	5.8	5.24	13.51	22.35	38.67	44.89	87.97	100.00	2.52	44.89	43.09	12.03
716E	180	6.6	4.27	11.69	21.57	38.77	45.73	89.58	100.00	3.80	45.73	43.84	10.42
716E	190	5.8	3.36	9.38	17.94	32.24	36.95	85.59	100.00	0.69	36.95	48.64	14.41
716E	200	6.2	3.27	9.22	17.31	32.90	38.55	82.32	100.00	1.62	38.55	43.77	17.68
716E	210	10.6	3.81	9.86	18.17	32.46	38.40	89.71	100.00	4.21	38.40	51.31	10.29
716E	220	9.4	2.90	8.01	15.40	28.82	34.32	85.51	100.00	3.05	34.32	51.18	14.49
716E	230	8.1	3.21	9.73	22.18	37.82	43.30	85.10	100.00	0.68	43.30	41.80	14.90
716E	240	2.7	2.96	9.26	19.39	31.25	35.61	83.91	100.00	0.88	35.61	48.30	16.09
716E	250	3.7	3.59	9.78	22.02	33.00	38.50	88.89	100.00	0.50	38.50	50.39	11.11
716E	260	4.4	4.65	12.11	21.32	35.16	38.82	90.19	100.00	0.90	38.82	51.37	9.81
716E	270	3.9	4.30	10.71	21.17	34.03	39.65	91.36	100.00	0.85	39.65	51.71	8.64
716E	280	4.6	4.29	11.96	22.02	36.61	43.05	89.81	100.00	2.11	43.05	46.75	10.19
716E	290	4.4	4.63	11.51	20.94	34.42	40.08	88.79	100.00	3.25	40.08	48.71	11.21

Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
717E	15	1.0	72.0	4.5	2.5	20.0	0.17	0.89	7.25	33.90	2.04	2.31	0.44	4.10
717E	20	1.0	73.0	3.5	1.0	21.5	0.27	0.87	8.62	31.48	2.01	3.61	0.54	4.49
717E	25	1.0	80.0	2.5	1.5	15.0	0.0	0.95	7.24	33.65	2.01	3.50	0.39	3.33
717E	30	4.5	68.5	5.0	2.5	19.5	0.0	1.06	7.36	33.99	1.97	2.82	0.34	3.41
717E	35	1.5	65.8	4.0	5.4	23.3	0.29	1.01	7.35	33.70	2.00	3.27	0.31	3.25
717E	40	3.0	68.0	4.0	1.5	23.5	0.50	1.02	7.18	33.54	2.06	3.05	0.51	3.48
717E	60	3.5	61.0	4.5	4.5	26.5	0.35	1.09	6.51	34.52	1.94	3.01	0.42	3.14
717E	120	14.0	50.5	3.0	4.5	28.0	0.0	0.71	7.87	33.19	1.97	2.44	0.47	4.43
717E	130	9.0	68.5	3.0	2.0	17.5	0.20	0.77	7.93	33.57	2.03	2.06	0.45	4.05
717E	140	5.1	63.4	1.7	2.3	27.4	0.28	0.86	7.59	33.82	1.87	2.69	0.46	3.42
717E	150	2.0	63.0	2.0	4.5	28.5	0.0	0.53	7.36	34.48	2.01	2.63	0.47	3.77
717E	160	7.5	58.0	0.5	0.5	33.5	0.60	0.92	8.05	32.16	2.03	3.69	0.52	3.76
717E	170	3.5	57.5	2.0	7.0	30.0	0.0	0.67	8.01	33.53	1.81	2.29	0.49	4.21
717E	210	5.0	52.0	3.0	12.5	27.5	0.20	0.79	8.46	32.88	1.86	2.32	0.38	4.33
718E	10	4.2	66.3	1.1	0.0	28.4	0.13	0.54	7.91	33.94	2.04	1.67	0.53	4.14
718E	20	3.5	62.0	5.0	5.5	24.0	0.0	0.53	7.19	35.12	1.88	1.82	0.50	3.46
718E	30	63.0	26.0	0.0	0.5	10.5	0.52	0.44	9.52	32.17	1.48	1.59	0.54	4.97
718E	40	3.5	59.0	3.0	6.5	28.0	0.0	0.98	7.19	33.73	2.09	3.08	0.41	3.59
718E	50	2.0	69.5	5.0	1.5	22.0	0.0	0.26	7.85	33.83	1.98	1.85	0.44	4.84
718E	60	7.0	55.5	5.0	4.5	28.0	0.0	0.65	8.13	33.29	2.28	2.34	0.49	3.99
718E	70	3.5	65.5	3.5	5.5	22.0	0.0	0.70	8.28	33.49	2.11	2.10	0.47	3.84
718E	80	12.0	59.5	5.0	6.0	17.5	0.39	0.73	8.11	33.29	1.91	2.28	0.47	3.96
718E	90	4.0	69.5	2.5	4.0	20.0	0.0	0.71	7.92	33.83	1.97	2.29	0.45	3.73

Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
718E	100	5.0	59.5	1.5	6.0	28.0	0.0	0.39	8.26	33.83	1.97	2.02	0.50	3.89
718E	110	3.0	64.0	5.0	2.0	26.0	0.0	0.51	7.26	35.31	1.88	1.80	0.45	3.65
718E	120	10.0	55.5	2.5	3.5	28.5	0.0	0.50	7.75	33.98	2.08	2.05	0.50	4.08
718E	130	11.0	58.5	3.5	0.5	26.5	0.0	0.49	6.90	35.31	1.83	1.79	0.53	3.65
718E	140	4.0	69.5	2.5	2.0	22.0	0.0	0.39	6.96	35.53	1.74	1.48	0.51	3.56
718E	150	7.3	70.9	2.0	3.3	16.6	0.0	0.33	7.88	34.19	2.00	1.84	0.44	4.14
718E	160	10.0	58.5	2.0	7.0	22.5	0.0	0.80	8.38	33.09	1.95	2.36	0.54	3.99
718E	170	6.5	61.5	4.0	1.0	27.0	0.0	0.96	7.49	33.07	2.07	3.66	0.39	3.80
718E	180	7.5	60.5	2.5	5.5	24.0	0.0	0.45	8.35	32.85	2.10	2.56	0.47	4.60
718E	190	4.0	67.3	3.5	2.5	22.8	0.0	0.80	7.88	33.34	2.15	2.47	0.46	4.10
718E	200	1.0	68.5	5.5	2.5	22.5	0.0	0.49	7.67	33.99	2.00	2.24	0.43	4.16
718E	210	2.0	70.5	3.0	5.0	19.5	0.0	0.58	7.40	33.99	2.03	2.36	0.50	4.08
719E	10	8.5	66.0	3.0	4.5	18.0	0.0	0.83	7.54	33.73	2.02	2.77	0.46	3.74
719E	20	7.0	62.5	4.0	2.5	24.0	0.0	1.12	8.05	32.64	2.20	3.30	0.41	3.74
719E	30	4.5	63.0	2.5	4.0	26.0	0.35	1.02	8.12	32.84	2.10	2.87	0.41	3.64
719E	40	1.5	73.5	3.5	2.0	19.5	0.57	1.17	7.23	32.91	2.18	3.64	0.38	3.55
719E	50	0.0	69.5	6.0	4.0	20.5	0.0	1.04	7.46	33.63	2.00	2.79	0.43	3.76
719E	60	1.0	68.5	3.0	3.0	26.5	0.0	0.22	7.53	35.02	1.91	1.84	0.41	3.58
719E	70	3.0	67.5	2.5	4.0	23.0	0.0	0.60	8.76	32.85	2.03	2.07	0.38	4.51
719E	80	3.0	65.5	4.5	1.5	25.5	0.15	0.79	7.77	33.68	1.96	2.13	0.50	3.88
719E	90	1.0	58.5	3.0	7.0	30.5	0.0	0.55	7.22	34.40	1.99	2.44	0.52	3.74
719E	100	1.5	61.0	1.0	5.0	31.5	0.0	0.41	6.91	35.16	1.94	2.12	0.51	3.53
719E	110	6.0	54.5	6.0	5.5	28.0	0.0	0.56	8.58	32.96	2.03	2.24	0.52	4.27

Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
723E	5	4.1	65.5	1.4	0.0	29.1	0.0	0.50	7.51	34.58	2.08	1.38	0.57	4.07
723E	10	2.0	67.0	2.5	4.1	24.4	0.0	0.46	6.98	34.66	1.88	2.38	0.48	3.99
723E	15	8.5	65.5	0.5	4.0	21.5	0.0	0.63	6.95	35.06	1.84	2.32	0.48	3.31
723E	20	1.0	72.5	6.0	1.5	19.0	0.0	0.69	7.23	34.48	1.90	2.45	0.45	3.60
723E	25	2.5	70.5	5.5	1.5	20.0	0.0	0.58	7.35	34.29	1.98	2.39	0.48	3.82
723E	30	5.0	60.0	7.5	4.0	23.5	0.0	0.72	7.38	34.13	1.94	2.44	0.46	3.74
723E	35	3.0	69.0	3.5	3.0	21.5	0.0	0.48	7.16	34.67	2.01	2.35	0.49	3.61
723E	40	7.5	62.5	5.0	3.5	21.5	0.0	0.84	7.20	34.30	1.84	2.51	0.50	3.68
723E	45	7.5	60.0	2.5	5.5	24.5	0.0	0.76	7.30	34.30	1.90	2.39	0.44	3.64
723E	50	6.5	60.5	4.5	2.5	26.0	0.0	0.71	8.20	32.77	2.11	2.84	0.43	4.34
723E	55	1.5	76.0	2.0	1.0	19.5	0.0	0.69	7.03	35.13	1.78	2.33	0.41	3.14
723E	60	5.5	59.0	4.5	2.0	29.0	0.0	0.81	7.61	33.43	1.68	3.26	0.38	4.02
723E	65	4.5	65.0	5.5	1.5	23.5	0.16	0.77	7.42	34.13	1.83	2.58	0.47	3.54
723E	70	7.5	62.0	2.5	2.0	26.0	0.0	0.49	7.49	34.78	1.86	2.31	0.38	3.29
723E	75	10.5	65.0	4.5	2.5	17.5	0.16	0.60	7.08	34.85	1.80	2.32	0.43	3.43
723E	80	8.0	57.5	3.0	2.0	29.5	0.37	0.92	7.27	33.44	1.89	3.71	0.40	3.32
723E	85	18.5	52.0	1.0	2.5	26.0	0.0	0.45	7.46	33.80	1.89	2.84	0.36	4.36
723E	90	5.5	53.5	5.0	2.0	34.0	0.0	0.74	8.04	33.25	1.89	2.79	0.41	4.05
723E	100	4.6	65.6	3.3	1.3	25.2	0.0	0.95	8.41	32.29	1.61	3.39	0.47	4.34
723E	105	34.0	41.5	1.5	1.5	21.5	0.0	0.33	7.94	33.72	1.74	2.78	0.43	4.08
725E	10	4.0	69.0	1.0	1.5	24.5	0.0	1.03	7.62	32.87	2.07	2.54	0.39	4.74
725E	15	6.7	65.9	3.7	2.4	21.3	0.16	1.08	7.33	33.47	2.12	3.05	0.49	3.55
725E	20	2.5	76.0	4.0	1.0	16.5	0.0	1.05	7.53	33.34	2.11	2.83	0.37	4.06
725E	25	1.0	66.5	6.0	0.5	26.0	0.0	1.13	7.63	32.96	2.14	3.15	0.45	3.97

5

Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtr.	Na	Mg	Al	Si	K	Ca	Ti	Fe
725E	30	16.5	61.5	4.5	1.5	16.0	0.0	1.14	7.85	32.68	1.89	3.43	0.44	4.02
725E	35	11.0	68.5	2.5	1.0	17.0	0.0	1.26	7.76	32.67	1.99	3.38	0.41	3.91
725E	40	7.0	72.5	4.0	2.5	14.0	0.0	0.98	7.54	33.55	2.00	3.12	0.35	3.62
725E	45	2.1	71.3	4.9	1.4	20.3	0.0	1.09	6.85	33.77	2.09	3.53	0.44	3.34
725E	60	8.5	64.5	5.5	3.0	18.5	0.53	1.10	8.22	32.02	1.97	3.25	0.45	4.19
725E	65	45.5	37.0	4.0	0.5	13.0	0.0	1.02	7.82	33.21	1.98	2.73	0.42	4.04
725E	70	41.5	41.0	3.0	1.0	13.5	0.0	0.82	8.29	33.02	2.05	2.45	0.37	4.21
725E	75	1.5	62.0	5.0	3.0	28.5	0.0	1.27	7.76	32.62	2.05	3.44	0.45	3.88
725E	80	1.6	69.2	6.6	0.5	22.0	0.0	1.15	7.55	32.95	1.90	3.65	0.44	3.80
725E	85	4.5	80.3	3.8	0.8	10.6	0.0	1.32	7.53	32.59	1.88	3.76	0.51	3.79
725E	90	13.5	63.5	2.7	0.7	19.6	0.0	0.85	8.76	32.16	2.33	2.51	0.40	4.53
725E	95	50.5	34.0	1.0	7.5	7.0	0.0	0.70	6.23	34.84	1.81	3.60	0.46	3.28
725E	100	17.0	49.5	7.0	4.5	22.0	0.0	0.46	6.50	34.89	1.88	3.38	0.45	3.11
725E	105	12.5	62.5	11.0	2.0	12.0	0.0	0.63	7.67	33.53	2.15	3.09	0.34	3.82
725E	108	6.0	75.0	3.0	2.5	13.5	0.0	1.17	8.18	32.64	2.19	2.86	0.41	3.95
725E	115	34.0	50.0	1.5	2.0	12.5	0.0	0.58	7.35	34.35	2.05	2.85	0.36	3.35
725E	120	14.5	62.0	2.5	3.5	17.5	0.0	0.74	8.04	33.15	2.21	3.01	0.39	3.75
725E	125	41.0	41.5	1.5	2.5	13.5	0.0	1.19	8.14	32.53	2.24	3.15	0.44	3.78
725E	130	20.5	56.0	5.0	2.0	16.5	0.0	0.98	7.40	33.54	2.18	2.86	0.41	3.86
725E	136	2.0	78.5	1.0	2.0	16.5	0.23	1.06	7.59	32.96	2.16	2.93	0.48	3.77
725E	140	13.0	66.5	1.5	2.0	17.0	0.0	0.62	7.75	33.13	2.41	3.28	0.39	3.67
725E	145	6.0	68.7	2.4	3.6	19.3	0.0	0.85	8.30	33.17	2.26	2.40	0.48	3.68
725E	150	1.0	70.5	5.0	4.0	19.5	0.0	1.20	7.81	32.42	2.28	3.54	0.41	4.01
725E	155	10.0	67.5	5.5	1.0	16.0	0.0	0.89	7.69	33.34	2.14	3.11	0.31	3.79
725E	160	6.5	57.5	5.5	2.5	28.0	0.23	1.20	8.33	32.34	2.04	2.91	0.48	3.94

Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
725E	165	6.5	68.0	3.5	2.5	19.5	0.20	1.11	7.81	32.82	2.22	3.08	0.39	3.82
725E	170	1.0	66.0	5.5	7.0	20.5	0.0	0.88	7.34	33.63	2.16	3.38	0.40	3.43
725E	175	21.5	59.5	3.0	1.0	15.0	0.0	0.90	7.75	33.63	2.14	2.57	0.32	3.55
725E	180	20.5	54.5	1.5	1.0	22.5	0.0	1.00	9.02	32.02	2.25	2.49	0.47	4.22
725E	190	22.5	59.0	1.0	2.0	15.5	0.0	1.06	7.91	32.92	2.22	2.98	0.38	3.93
725E	195	1.0	73.5	4.0	3.0	18.5	0.0	0.80	7.27	34.04	1.98	3.03	0.37	3.43
725E	200	4.5	64.0	3.5	1.5	26.5	0.0	1.15	7.81	33.08	2.15	3.07	0.41	3.63
725E	210	2.0	75.0	4.5	2.5	16.0	0.0	1.22	7.32	32.98	2.13	3.47	0.35	4.04
725E	220	0.0	68.0	6.0	0.5	25.5	0.0	0.94	7.57	33.20	2.10	3.37	0.48	3.67
725E	230	5.5	63.0	9.5	0.5	21.5	0.0	0.79	8.02	32.93	2.20	3.07	0.27	4.03
725E	240	2.1	68.1	2.1	3.2	24.5	0.0	1.28	8.13	32.28	2.21	3.18	0.46	4.05
725E	250	7.5	63.0	4.0	2.0	23.5	0.0	0.93	8.18	32.44	2.24	3.11	0.50	4.15
725E	255	7.0	64.5	4.5	3.0	21.0	0.0	1.04	7.46	33.38	1.95	3.31	0.39	3.72
726E	10	1.9	71.8	2.9	2.9	20.4	0.0	1.06	8.69	32.33	2.08	2.70	0.40	4.14
726E	20	1.5	73.5	7.0	2.5	15.5	0.0	1.23	8.25	32.25	2.31	3.23	0.34	3.99
726E	30	27.5	53.5	2.0	0.5	16.5	0.0	0.85	7.85	33.34	2.20	2.62	0.37	3.98
726E	40	15.8	61.9	2.2	2.2	18.0	0.16	1.21	7.79	32.95	2.16	2.69	0.38	3.88
725E	50	18.5	55.5	1.5	3.0	21.5	0.59	1.08	7.92	32.59	2.30	2.93	0.39	3.91
726E	55	11.0	61.5	3.5	1.0	23.0	0.24	0.80	7.77	33.73	1.94	2.21	0.43	3.89
726E	60	8.5	55.0	5.0	1.0	30.5	0.46	0.99	7.77	33.24	2.07	2.42	0.47	3.82
725E	70	3.5	58.5	4.0	4.5	29.5	0.0	0.60	7.75	33.90	1.94	2.12	0.48	4.10
726E	80	4.0	63.5	10.0	2.0	20.5	0.0	0.75	7.07	34.26	1.97	2.77	0.50	3.64
726E	90	6.0	59.0	5.0	1.5	20.5	0.25	0.80	7.80	33.48	2.07	2.38	0.45	3.81
726E	100	8.5	52.0	0.5	4.0	35.0	0.0	0.26	7.62	34.48	1.97	2.04	0.49	3.88

Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
726E	120	13.0	48.4	4.3	3.1	31.1	0.37	0.72	7.89	33.62	2.10	1.93	0.32	4.14
726E	140	3.5	60.9	2.0	3.0	30.7	0.0	0.42	8.04	34.09	1.89	1.97	0.44	3.92
726E	150	8.5	54.5	3.5	3.5	30.0	0.0	0.69	7.41	34.14	1.94	2.29	0.46	4.00
726E	160	9.5	61.0	3.5	2.5	23.5	0.35	0.54	6.97	34.92	1.99	1.74	0.49	3.69
726E	170	4.2	66.4	4.9	1.4	23.1	0.16	0.46	7.39	34.80	1.99	1.59	0.50	3.75
726E	180	0.0	57.0	4.5	4.0	34.5	0.19	0.50	7.26	34.67	2.00	1.83	0.52	3.77
726E	190	2.5	70.0	6.0	1.0	20.5	0.0	0.55	8.12	33.43	2.00	2.70	0.44	3.85
728E	20	83.0	11.5	0.0	0.0	5.5	0.0	0.76	6.78	34.46	1.85	3.04	0.43	3.64
728E	30	37.6	38.6	4.0	2.5	17.3	0.13	0.96	7.07	33.27	1.74	4.24	0.37	3.44
728E	40	2.5	76.5	4.0	1.5	15.5	0.0	0.80	7.20	34.28	1.84	2.69	0.37	3.75
728E	50	2.0	68.0	6.0	4.5	19.5	0.40	1.48	7.02	32.87	2.03	3.74	0.33	3.77
728E	60	1.0	58.0	4.5	3.0	33.5	0.0	0.49	7.16	34.54	1.62	2.55	0.49	3.95
728E	70	1.0	48.0	30.0	2.5	18.5	0.0	0.50	7.45	34.02	2.01	2.34	0.46	4.25
728E	80	3.5	67.0	0.5	1.0	28.0	0.0	0.43	7.44	34.34	1.90	2.29	0.49	3.97
728E	88	2.5	56.5	8.5	2.0	30.5	0.0	0.73	7.79	33.42	1.74	2.56	0.50	4.40
729E	10	6.5	59.5	4.5	3.5	26.0	0.20	0.93	6.00	35.35	1.63	3.27	0.43	3.00
729E	20	0.5	66.0	5.0	4.0	24.5	0.0	0.83	7.09	34.07	1.82	2.97	0.43	3.82
729E	30	0.5	67.5	5.5	5.0	21.5	0.0	0.82	7.43	33.72	1.90	2.89	0.44	3.92
756E	5	4.4	62.6	3.4	3.4	26.1	0.38	1.29	7.45	32.85	1.98	3.09	0.47	3.93
756E	15	2.0	69.5	3.5	2.0	23.0	0.49	1.51	7.39	32.06	2.09	4.04	0.39	3.97
756E	29	1.5	66.0	4.0	1.5	27.0	0.42	1.17	7.53	33.15	2.03	2.95	0.46	3.64
756E	40	2.0	67.7	2.0	7.0	21.4	0.48	1.02	7.41	33.22	2.02	3.13	0.40	3.71

Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
756E	50	3.5	62.5	3.5	4.0	26.5	0.28	1.24	7.48	33.26	2.09	2.90	0.46	3.58
756E	60	2.0	64.0	5.0	5.0	24.0	0.33	1.05	7.49	33.45	2.17	2.72	0.43	3.59
756E	70	2.0	72.0	3.5	1.5	21.0	0.32	1.15	7.40	33.30	2.14	2.87	0.38	3.67
756E	75	2.5	70.5	3.5	3.0	20.5	0.13	1.16	7.53	33.21	2.05	2.88	0.43	3.87
756E	80	1.0	58.5	7.0	1.5	32.0	0.54	1.14	7.20	33.32	2.07	2.86	0.41	3.72
756E	90	1.0	72.0	4.0	4.0	19.0	0.59	1.14	7.12	33.44	2.07	2.85	0.43	3.72
756E	100	9.0	60.2	3.3	1.9	25.6	0.18	0.99	6.60	34.23	1.95	3.12	0.41	3.39
756E	105	2.0	67.5	5.5	2.0	23.0	0.16	1.16	7.27	33.26	2.13	3.05	0.42	3.85
756E	110	9.0	65.5	5.0	2.0	18.5	0.31	1.31	7.54	32.69	2.10	3.06	0.50	3.86
755E	120	1.0	68.5	6.5	3.5	20.5	0.47	1.57	7.67	31.92	2.15	3.96	0.37	3.80
756E	130	1.5	68.0	6.5	3.0	21.0	0.51	1.55	7.43	32.05	2.17	3.79	0.42	3.92
756E	135	1.5	77.0	5.0	1.5	15.0	0.38	1.34	8.13	32.56	2.21	2.87	0.41	3.55
757E	10	1.4	63.1	5.0	4.3	26.2	0.0	0.81	7.40	33.71	2.04	2.62	0.50	3.94
757E	20	1.0	61.0	3.0	2.0	33.0	0.19	0.98	7.57	32.82	2.04	3.01	0.44	4.33
757E	30	0.0	66.5	3.5	4.5	25.5	0.21	0.98	7.08	33.69	2.02	3.15	0.37	3.76
757E	40	3.0	58.0	3.0	7.0	29.0	0.0	0.93	7.20	33.52	2.07	3.21	0.41	3.98
757E	48	1.0	64.5	2.5	3.0	29.0	0.21	1.00	7.29	33.32	2.11	3.25	0.40	3.82
757E	50	0.5	62.5	3.5	4.5	29.0	0.0	0.77	7.44	34.17	1.80	2.76	0.41	3.51
757E	60	0.5	61.0	5.5	3.0	30.0	0.0	1.05	7.51	33.13	2.27	3.19	0.29	4.03
757E	70	0.0	73.0	5.5	3.5	18.0	0.0	0.88	7.27	33.80	2.06	2.80	0.47	3.85
757E	80	1.5	68.5	2.5	5.5	22.0	0.0	0.89	7.46	33.30	2.15	3.12	0.46	3.98
757E	90	1.5	60.5	5.0	2.5	30.5	0.0	1.07	7.22	33.63	2.14	3.14	0.37	3.67
757E	100	0.5	64.0	5.5	3.0	27.0	0.18	1.08	7.45	33.07	2.14	3.13	0.45	3.98
757E	108	0.0	65.5	7.0	4.5	23.0	0.0	1.07	7.17	33.65	2.09	2.96	0.44	3.85

Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
757E	320	13.6	53.8	6.0	2.0	24.6	0.0	0.81	8.08	33.01	1.91	2.62	0.51	4.32
758E	60	0.5	42.0	37.5	3.0	17.0	0.48	1.03	7.28	33.35	1.93	3.09	0.44	3.76
758E	68	0.0	65.6	5.3	3.3	25.8	0.36	1.11	7.68	32.78	1.84	3.30	0.45	3.95
758E	90	1.5	68.5	2.5	4.0	23.5	0.0	0.89	7.53	32.88	1.96	3.47	0.50	4.08
758E	120	1.5	70.0	5.0	2.5	21.0	0.0	0.64	7.68	33.51	1.87	2.17	0.46	4.71
758E	150	19.0	60.5	1.9	2.9	15.7	0.0	0.76	7.75	33.26	1.61	2.86	0.62	4.23
758E	180	5.5	62.0	3.0	3.0	26.5	0.0	0.70	7.53	34.13	1.75	2.02	0.54	4.03
758E	210	1.0	44.9	6.1	24.2	23.7	0.0	0.52	7.42	34.19	1.76	2.20	0.52	4.18
758E	240	0.0	62.7	3.0	1.5	32.8	0.0	0.66	7.47	34.00	1.62	2.47	0.58	4.13
758E	270	3.3	68.1	4.8	3.3	20.5	0.0	0.44	7.54	34.45	1.82	1.68	0.50	4.32
758E	300	3.0	53.5	4.5	7.0	32.0	0.0	0.55	7.34	34.65	1.84	1.76	0.43	4.02
758E	330	1.4	71.7	0.7	1.4	24.8	0.0	0.72	8.04	32.80	1.95	2.81	0.56	4.30
759E	20	1.6	65.8	4.1	3.6	24.9	0.0	0.55	7.87	34.01	1.97	2.16	0.38	3.94
759E	30	6.0	67.0	5.5	3.5	18.0	0.0	0.61	7.55	34.24	1.96	2.19	0.40	3.90
759E	43	8.0	59.5	3.0	1.5	28.0	0.0	0.62	7.55	33.74	2.00	2.42	0.52	4.24
759E	50	5.5	59.0	5.0	3.0	27.5	0.0	0.29	7.58	34.31	1.94	2.33	0.57	3.82
760E	10	0.0	61.0	4.0	13.0	22.0	0.81	1.41	7.43	32.04	2.13	3.70	0.42	4.01
760E	20	0.0	70.0	7.0	2.5	20.5	0.66	1.41	7.53	31.56	2.11	4.27	0.51	4.11
760E	30	0.5	71.5	4.5	4.0	[illegible]	0.35	1.25	7.48	31.85	2.09	4.10	0.49	4.35
760E	40	3.5	58.5	7.5	9.0	21.5	0.54	1.44	7.52	31.96	2.08	4.37	0.47	3.56
760E	50	3.0	79.0	3.0	1.0	14.0	0.72	1.44	7.42	32.00	2.12	4.09	0.45	3.72
760E	60	0.0	68.5	9.5	3.5	18.5	0.68	1.45	6.63	32.50	2.02	4.39	0.67	3.58

Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
760E	65	1.5	65.5	7.5	4.0	21.5	0.62	1.21	7.30	32.73	2.07	3.80	0.41	3.53
760E	70	0.5	67.0	5.0	5.5	22.0	0.67	1.26	7.09	32.66	2.02	4.18	0.39	3.48
760E	75	7.5	65.0	5.0	2.5	20.0	0.22	0.73	7.33	33.67	1.99	2.44	0.56	4.14
760E	80	2.5	65.0	6.0	5.5	21.0	0.24	1.31	7.03	32.82	1.96	4.30	0.39	3.55
760E	90	2.5	67.0	4.5	2.0	24.0	0.23	1.05	7.14	33.25	2.00	3.81	0.44	3.51
760E	100	6.5	54.5	3.5	4.5	31.0	0.25	0.90	7.08	33.81	1.97	3.44	0.34	3.40
760E	110	2.0	63.0	3.5	4.0	27.5	0.35	1.31	7.34	32.28	2.13	4.21	0.43	3.81
760E	120	1.0	62.0	3.5	9.5	24.0	0.58	1.38	7.28	32.55	2.05	3.94	0.43	3.53
761E	20	1.5	67.3	3.0	4.0	24.3	0.71	1.53	7.47	32.35	2.12	3.34	0.46	3.78
761E	25	4.2	50.0	23.2	2.6	20.0	0.55	1.10	7.32	33.22	2.12	2.78	0.49	3.83
761E	40	9.5	70.5	5.0	1.5	13.5	0.49	1.57	7.24	32.27	2.08	4.11	0.40	3.59
761E	50	1.0	68.5	6.5	4.5	19.5	0.51	1.52	7.10	32.07	2.06	4.03	0.46	4.25
761E	60	6.0	67.5	3.5	4.0	19.0	0.0	1.27	6.83	32.74	1.97	4.43	0.51	3.82
761E	70	1.5	63.0	6.5	4.5	24.5	0.51	1.31	7.56	32.31	2.00	3.51	0.48	3.99
761E	75	3.5	76.5	6.5	3.5	10.0	0.44	1.36	7.60	32.20	2.06	3.87	0.43	3.68
761E	80	1.0	62.0	3.5	13.0	20.5	0.42	1.49	7.58	31.99	2.04	4.23	0.40	3.74
761E	90	1.7	76.7	3.3	1.7	16.7	0.70	1.34	6.50	33.27	2.00	3.94	0.44	3.34
761E	100	0.5	78.0	10.5	1.0	10.0	0.48	1.66	7.14	31.98	2.11	4.30	0.45	3.92
761E	105	0.0	74.0	3.5	9.0	13.5	0.66	1.55	7.34	31.68	2.02	4.59	0.43	3.73
761E	115	2.0	71.3	5.9	4.5	16.3	0.54	0.94	7.39	33.10	2.26	3.55	0.39	3.24
761E	125	2.0	69.5	4.0	4.0	20.5	0.20	1.09	7.38	32.95	2.07	3.67	0.37	3.80
761E	135	1.0	52.5	5.5	16.0	25.0	0.54	1.19	6.81	33.38	1.97	4.06	0.36	3.09
761E	150	22.5	49.5	5.5	8.0	14.5	0.20	1.36	7.56	32.27	2.09	3.95	0.43	3.90

Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
762E	20	4.0	75.0	3.4	2.3	15.3	0.21	1.50	7.62	32.45	2.07	3.45	0.44	3.78
762E	240	11.0	62.5	3.5	3.5	19.5	0.32	1.13	7.77	32.55	2.01	3.14	0.43	4.08
762E	245	7.0	58.0	5.0	3.0	27.0	0.58	1.08	7.03	33.38	2.03	3.47	0.46	3.29
763E	40	0.[illegible]	76.5	6.0	2.5	15.0	0.75	2.37	6.51	31.20	1.99	5.71	0.46	3.52
763E	50	4.0	58.0	7.5	15.5	15.0	0.66	2.47	6.63	31.08	2.04	5.92	0.40	3.33
763E	60	1.0	74.0	6.0	1.5	17.5	0.56	0.95	7.08	34.45	1.98	3.19	0.34	2.36
763E	75	2.5	70.0	5.5	4.0	18.0	0.27	1.05	7.19	33.03	2.02	3.52	0.42	3.84
763E	80	1.5	57.5	4.5	13.0	23.5	0.27	1.11	6.94	33.68	1.87	3.69	0.36	3.33
763E	90	2.5	70.0	7.5	3.0	17.0	0.49	1.43	7.81	31.94	2.01	4.14	0.46	3.55
763E	100	3.0	67.0	7.5	2.5	20.0	0.38	1.28	7.34	32.61	2.00	3.92	0.41	3.74
763E	110	0.5	57.0	4.0	5.5	33.0	0.37	1.30	7.35	32.34	2.00	4.02	0.47	3.87
764E	5	1.9	66.7	3.3	6.2	21.9	0.50	1.41	7.48	32.32	2.09	3.69	0.48	3.80
764E	45	1.5	57.0	5.0	10.5	26.0	0.56	1.00	9.73	31.80	1.61	3.27	0.35	2.95
764E	55	2.0	70.0	3.5	3.0	21.5	0.25	1.36	7.25	32.62	1.94	4.12	0.47	3.67
764E	65	1.0	63.5	6.5	4.5	24.5	0.52	0.98	7.02	33.46	1.94	3.66	0.45	3.36
764E	90	1.0	59.5	4.0	10.5	25.0	0.47	1.53	6.77	32.81	2.01	4.48	0.38	3.28
764E	98	6.0	63.5	5.0	3.0	22.5	0.73	1.78	7.34	31.86	2.04	4.56	0.41	3.29
764E	111	0.5	75.0	3.5	4.0	17.0	0.50	1.73	7.00	32.19	2.02	4.79	0.40	3.35
764E	120	7.5	55.0	3.0	8.5	26.0	0.66	1.62	7.17	32.15	2.06	4.30	0.38	3.59
764E	125	2.0	75.0	5.5	2.5	15.0	0.47	1.79	6.83	32.48	2.05	4.56	0.40	3.25
764E	135	10.5	65.0	2.5	2.0	20.0	0.48	1.31	7.69	32.69	2.11	3.18	0.42	3.65
764E	144	23.5	43.5	3.5	6.0	23.5	0.55	1.36	7.64	32.47	2.16	3.44	0.36	3.69
764E	155	13.5	56.5	5.5	5.0	19.5	0.13	1.30	7.71	31.22	2.08	5.23	0.40	4.21

Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
765E	30	6.2	64.3	4.3	2.9	22.4	0.39	1.43	7.88	32.40	2.20	3.22	0.45	3.67
765E	50	1.5	61.0	3.5	7.5	26.5	0.35	1.46	7.61	32.60	2.11	3.33	0.41	3.72
765E	70	8.8	54.4	7.4	0.7	28.7	0.12	1.35	8.86	31.53	2.28	2.65	0.44	4.43
765E	99	1.0	73.0	5.5	2.0	18.5	0.58	1.34	7.61	32.35	2.11	3.92	0.41	3.34
765E	110	1.5	63.[illegible]	5.0	10.5	20.0	0.39	1.18	7.35	33.20	2.02	3.63	0.37	3.26
765E	297	0.5	63.0	6.0	4.0	26.5	0.0	0.76	7.47	32.61	1.99	2.45	0.45	5.70
765E	300	2.5	69.5	5.5	3.0	19.5	0.28	0.90	7.32	33.49	1.93	3.47	0.43	3.46
795E	20	1.5	55.5	3.5	5.5	34.0	0.27	0.72	7.93	34.06	1.95	2.33	0.40	3.14
795E	25	0.0	73.5	2.0	2.0	22.5	0.35	0.82	7.85	33.85	1.98	2.40	0.34	3.35
795E	50	1.0	68.0	2.5	7.0	21.5	0.37	1.08	6.98	34.00	1.99	2.78	0.45	3.36
795E	75	2.4	64.9	3.4	5.3	22.9	0.36	1.11	7.11	33.77	1.98	3.04	0.39	3.41
795E	145	2.5	65.0	7.5	3.0	22.0	0.24	1.07	7.33	33.63	1.99	2.94	0.39	3.59
797E	20	7.0	71.0	3.0	2.0	17.0	0.0	0.70	7.39	35.22	1.83	2.01	0.31	2.82
797E	40	5.0	62.5	3.5	5.5	23.5	0.0	0.61	8.28	34.51	2.05	1.76	0.37	2.90
797E	60	3.0	62.0	4.0	8.0	23.0	0.38	0.75	7.76	34.38	1.90	2.12	0.35	3.06
797E	80	5.5	58.5	8.0	3.5	24.5	0.09	1.05	7.58	33.69	1.94	2.43	0.48	3.77
797E	100	1.0	67.0	7.5	4.5	20.0	0.09	0.76	7.97	33.95	1.97	2.30	0.42	3.22
797E	170	7.0	59.0	5.0	8.5	20.5	0.64	1.00	8.07	32.53	2.13	2.35	0.45	4.20
797E	190	4.0	64.5	4.0	4.5	23.0	0.18	0.70	7.98	34.18	1.91	1.66	0.44	3.67
797E	230	2.0	64.5	2.0	1.5	30.0	0.0	0.59	7.60	33.94	2.02	2.04	0.57	4.20
797E	250	4.0	62.5	6.5	3.5	[illegible].5	0.14	0.72	8.30	33.58	1.91	1.94	0.41	3.92

Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
797E	270	5.0	60.5	3.0	5.5	26.0	0.0	0.66	7.91	33.75	1.93	2.01	0.50	4.08
797E	290	68.5	22.0	0.0	1.5	8.0	0.20	0.79	8.34	32.46	1.98	2.56	0.45	4.73
797E	330	10.0	44.0	4.0	5.5	36.5	0.11	0.56	7.51	34.86	1.80	1.38	0.50	3.66
797E	335	11.5	59.0	4.0	2.5	23.0	0.11	0.64	7.53	34.52	1.85	1.43	0.53	4.05
797E	340	12.2	52.8	9.4	1.1	24.8	0.12	0.73	7.56	34.49	1.85	1.73	0.57	3.59
798E	10	7.5	65.5	5.5	4.0	17.5	0.0	0.56	7.77	34.84	1.63	1.63	0.29	3.71
798E	30	2.6	67.9	5.8	3.2	20.5	0.30	0.92	7.98	33.65	1.98	2.08	0.40	3.65
798E	50	6.0	57.0	7.0	7.0	23.[illegible]	0.20	0.93	7.51	34.21	1.90	2.23	0.43	3.40
798E	70	1.0	74.5	5.0	2.5	17.0	0.71	1.95	6.99	32.16	2.10	4.43	0.37	3.21
798E	90	0.5	72.0	5.0	3.5	19.0	0.41	1.94	8.01	31.16	2.18	4.25	0.40	3.64
798E	110	1.0	69.5	7.5	1.0	21.0	0.85	1.21	7.14	33.14	2.03	3.60	0.36	3.09
798E	130	0.5	63.0	11.0	3.5	22.0	0.63	1.28	7.42	32.61	2.14	3.51	0.44	3.65
798E	150	0.0	67.0	7.5	3.0	22.5	0.40	1.48	7.58	32.74	2.19	3.34	0.41	3.37
798E	170	0.0	71.5	5.5	4.0	19.0	0.23	1.54	8.39	31.56	2.49	3.26	0.37	3.38
798E	210	0.0	62.5	3.5	2.0	32.0	0.0	0.58	7.45	35.02	1.93	1.63	0.39	3.47
798E	230	3.0	62.0	3.0	0.5	31.5	0.10	0.54	7.48	34.93	1.85	1.77	0.43	3.40
798E	250	6.0	60.8	2.4	1.8	28.9	0.22	0.77	8.25	33.22	1.99	2.07	0.50	4.09
799E	10	0.0	65.0	5.0	1.5	28.5	0.55	1.34	7.41	33.16	2.03	3.33	0.34	3.20
799E	20	2.0	74.5	2.0	3.5	18.0	0.36	1.85	7.52	32.31	2.13	3.19	0.36	4.35
799E	30	0.0	73.5	4.5	4.0	18.0	0.49	3.02	6.62	29.68	2.02	7.35	0.34	3.67
799E	40	0.5	76.0	7.0	4.5	12.0	0.47	2.42	6.82	31.27	2.03	6.03	0.43	2.87
799E	50	1.0	56.0	3.0	19.0	21.0	0.54	2.67	5.99	31.50	1.94	6.60	0.38	2.80
799E	100	1.5	63.5	6.0	10.0	19.0	0.87	1.32	7.07	32.94	1.95	3.72	0.46	3.23

Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
799E	180	2.5	60.0	5.5	3.0	29.[illegible]	0.17	0.93	7.82	33.77	2.03	1.83	0.49	3.81
799E	185	0.5	73.0	3.5	1.5	21.5	0.56	1.20	8.19	32.24	2.10	2.98	0.50	3.76
801E	10	0.5	73.5	4.0	4.0	18.0	0.66	1.48	7.05	33.17	2.11	3.31	0.40	3.29
801E	20	0.5	61.0	6.0	2.5	30.0	0.18	1.42	7.35	33.02	2.07	3.53	0.36	3.52
801E	30	2.0	70.0	6.0	4.5	17.5	0.94	1.57	6.75	32.[illegible]	2.15	3.69	0.40	3.27
801E	40	21.0	56.5	3.0	1.0	18.5	0.44	1.75	7.75	31.65	2.10	4.07	0.45	3.75
801E	80	57.0	28.5	1.5	1.5	11.5	0.62	1.73	7.90	31.59	2.17	3.93	0.40	3.59
801E	85	6.0	64.5	4.0	2.5	23.0	0.22	1.11	7.39	33.21	2.03	3.20	0.49	3.70
801E	90	1.0	67.5	5.0	4.0	22.5	0.45	1.17	7.40	32.96	1.98	3.20	0.43	3.70
801E	190	8.0	65.5	2.0	2.0	22.5	0.16	0.77	6.92	34.90	1.93	2.24	0.45	3.19
801E	195	1.0	76.5	2.0	3.5	17.0	0.53	0.92	7.51	33.76	2.00	2.28	0.46	3.53
801E	200	3.5	67.0	4.0	3.5	22.0	0.52	0.94	6.60	34.63	1.93	2.77	0.47	2.97
802E	10	2.0	72.5	2.5	0.0	23.0	0.78	1.73	7.68	31.50	2.30	3.73	0.49	3.87
802E	15	2.0	74.0	4.0	1.5	18.5	0.78	1.73	7.68	31.50	2.30	3.73	0.49	3.87
802E	22	2.5	78.0	5.0	1.5	13.0	0.65	2.07	7.25	31.54	2.15	4.67	0.41	3.33
802E	25	3.0	77.0	[illegible]	1.0	16.0	0.59	1.77	7.14	32.31	2.12	4.15	0.40	3.29
802E	65	0.5	85.5	2.0	4.5	7.5	0.34	4.13	6.01	29.15	1.88	8.65	0.33	2.88
802E	67	0.5	72.0	6.5	4.0	17.0	0.81	3.45	6.88	28.46	1.88	8.08	0.40	3.68
802E	75	1.0	64.5	7.5	3.5	23.5	0.72	2.49	6.16	31.97	2.03	5.66	0.42	2.76
802E	85	3.0	60.0	2.0	2.0	33.0	0.60	2.25	7.49	30.82	2.04	4.94	0.50	3.69
802E	95	4.5	64.0	7.0	1.0	23.5	0.37	0.89	7.42	33.76	1.98	2.64	0.53	3.41
802E	110	3.0	63.5	1.5	0.5	31.5	0.22	1.00	7.16	33.46	1.97	3.40	0.40	3.72
802E	115	3.0	62.5	2.0	5.5	27.0	0.49	1.15	6.90	33.55	1.97	3.53	0.46	3.29

Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
802E	140	5.0	60.5	4.5	3.0	27.0	0.17	0.54	6.83	[illegible]	1.85	1.54	0.46	3.32
802E	175	34.5	31.0	4.5	3.5	26.5	0.22	0.83	8.21	33.02	2.02	2.60	0.45	3.87
802E	185	27.5	43.0	4.5	2.0	23.0	0.18	1.14	8.10	32.37	2.06	3.38	0.51	3.80
802E	195	48.0	29.0	4.0	3.0	16.0	0.0	0.80	8.75	33.02	2.06	1.58	0.48	4.35
804E	10	6.0	68.0	2.5	8.0	15.5	0.23	0.70	6.65	35.35	1.82	1.64	0.39	3.62
804E	20	56.0	25.5	0.5	0.0	18.0	0.56	2.15	6.79	31.85	1.99	5.11	0.40	3.25
804E	25	41.4	35.7	1.4	0.5	21.0	0.33	1.20	4.76	36.83	1.61	3.10	0.36	2.11
804E	30	12.9	61.9	0.5	1.0	23.8	0.46	1.51	6.16	34.54	1.75	3.33	0.43	2.81
804E	55	3.0	65.5	8.0	5.5	16.0	0.54	1.44	5.88	34.67	1.74	3.68	0.40	2.69
804E	60	1.5	66.0	8.5	5.0	19.0	0.39	2.44	6.96	31.11	1.97	5.49	0.42	3.60
804E	65	0.5	66.5	5.0	1.0	27.0	0.65	2.77	6.98	30.32	2.02	6.11	0.39	3.50
804E	70	5.0	67.0	2.5	3.0	22.5	0.78	2.45	6.98	31.01	2.09	5.37	0.37	3.42
804E	75	0.0	72.0	5.0	4.5	18.5	0.39	2.14	7.15	31.68	1.98	4.82	0.42	3.50
804E	80	3.5	66.5	6.0	4.0	20.0	0.23	2.26	8.13	30.23	2.09	5.48	0.37	3.70
804E	95	0.0	65.0	5.0	8.5	21.5	0.66	2.20	7.29	31.10	2.06	5.17	0.42	3.45
804E	100	2.0	64.5	4.5	5.0	24.0	0.55	1.98	7.48	31.47	2.06	4.46	0.42	3.69
804E	105	5.5	60.0	7.0	3.5	24.0	0.53	1.68	[illegible]	31.98	2.07	4.14	0.38	3.58
804E	108	4.5	54.5	6.0	4.5	30.5	0.35	1.48	7.60	31.43	2.02	4.53	0.50	4.15
804E	110	12.0	71.5	3.0	1.5	12.0	0.61	2.06	6.92	31.74	2.03	4.94	0.34	3.45
804E	115	1.5	59.6	3.9	3.9	31.0	0.60	1.41	7.27	32.31	2.06	4.17	0.42	3.62
804E	120	2.5	64.0	4.5	6.5	22.5	0.37	1.28	7.34	32.63	2.02	3.93	0.48	3.61
804E	125	1.0	58.0	4.5	5.0	31.5	0.33	0.75	6.97	34.74	1.81	2.23	0.43	3.47
804E	130	44.0	46.5	1.0	2.0	6.5	0.40	0.97	8.20	32.44	1.96	2.90	0.64	3.98
804E	185	96.4	2.7	0.0	0.0	0.9	0.0	0.53	10.01	31.83	2.20	1.71	0.50	4.54

Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
804E	190	56.5	27.0	0.5	0.0	16.0	0.18	0.87	7.30	34.23	1.87	2.66	0.48	3.28
804E	195	84.5	11.5	0.0	0.0	4.0	0.22	0.77	6.49	35.44	1.79	2.37	0.38	3.08
804E	200	46.8	42.6	2.1	0.0	8.4	0.39	0.83	7.02	34.62	1.83	2.09	0.50	3.49
804E	205	7.0	61.3	6.0	4.0	21.6	0.22	1.03	7.96	32.80	1.96	3.04	0.48	3.88
804E	210	71.0	20.0	1.0	3.0	5.0	0.47	1.04	8.39	32.18	2.01	2.83	0.47	4.09
804E	215	1.0	68.5	6.5	4.0	20.0	0.34	1.00	8.76	31.28	1.98	3.65	0.55	4.35
806E	5	5.5	71.5	1.5	2.0	19.5	0.47	1.65	7.34	32.57	2.03	3.47	0.46	3.64
806E	10	2.5	74.5	2.5	2.5	18.0	0.40	1.50	7.14	33.25	1.99	3.28	0.37	3.45
806E	15	17.6	51.9	2.4	3.8	24.3	0.45	1.37	7.98	32.29	2.01	2.82	0.45	4.23
806E	20	3.0	85.0	2.0	3.5	6.5	0.53	1.76	7.11	31.69	1.86	4.67	0.49	3.83
806E	30	0.0	59.0	5.0	8.0	28.0	0.0	1.97	6.39	32.20	2.08	5.52	0.39	3.35
806E	35	3.5	71.0	3.5	3.5	18.5	0.51	2.20	7.13	31.45	1.94	5.13	0.40	3.43
806E	40	1.0	63.5	9.5	4.5	21.5	0.71	2.10	6.99	31.49	1.89	5.15	0.45	3.46
806E	50	1.0	63.0	5.5	3.5	27.0	0.68	2.21	7.13	31.13	1.97	5.31	0.40	3.54
806E	55	2.5	69.0	3.5	6.5	18.5	0.73	2.21	7.17	31.29	2.01	5.10	0.39	3.38
806E	65	3.5	60.5	8.0	2.0	26.0	0.40	1.30	8.18	31.91	2.04	3.63	0.47	3.79
806E	70	4.0	53.0	7.0	3.0	33.0	0.64	1.28	7.81	32.00	2.15	3.64	0.45	3.88
806E	75	2.0	65.5	3.5	2.5	26.5	0.75	1.09	7.39	32.34	1.92	3.43	0.34	3.68
806E	85	1.0	66.5	4.0	2.5	26.0	0.36	1.15	7.91	32.60	1.93	3.45	0.37	3.70
806E	90	0.0	60.5	7.0	3.5	29.0	0.44	1.20	7.66	32.56	2.05	3.59	0.44	3.67
806E	95	0.0	49.5	5.0	5.5	40.0	0.31	1.08	7.65	32.95	2.01	3.37	0.51	3.54
806E	100	3.5	58.0	4.5	5.0	29.0	0.53	1.17	7.51	32.68	2.04	3.63	0.44	3.55
806E	105	4.0	68.0	3.0	2.5	22.5	0.58	1.10	7.38	32.91	1.87	3.78	0.42	3.48
806E	115	2.5	57.0	3.0	5.5	32.0	0.49	1.32	7.31	32.79	2.07	3.69	0.41	3.51

Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
806E	120	5.5	59.5	4.0	6.0	25.0	0.58	1.40	7.53	32.14	2.06	3.86	0.46	3.72
806E	125	3.0	52.0	5.0	4.0	36.0	0.36	1.16	7.69	32.57	2.06	3.49	0.47	3.72
807E	20	9.0	56.5	8.5	3.0	23.0	0.58	1.22	7.44	33.45	1.97	2.70	0.41	3.35
807E	30	62.5	26.0	1.0	1.5	9.0	0.0	1.04	8.04	33.42	1.95	2.45	0.47	3.58
807E	40	76.0	15.0	1.0	2.0	6.0	0.33	1.31	7.84	32.63	2.14	3.04	0.44	3.79
807E	50	4.0	76.5	3.5	1.0	15.0	0.64	1.52	8.13	31.57	2.12	3.87	0.37	3.61
807E	60	15.5	68.0	1.5	2.0	13.0	0.39	1.45	7.98	31.95	2.36	3.26	0.41	3.90
807E	70	25.0	61.5	2.0	0.5	11.0	0.81	1.53	8.28	31.20	2.58	3.53	0.42	3.80
807E	80	24.0	41.5	4.0	2.5	28.0	0.55	1.27	7.83	32.79	1.99	3.04	0.41	3.58
807E	90	24.5	63.5	1.5	0.5	10.0	0.43	1.36	7.56	32.54	2.08	3.44	0.48	3.67
807E	125	7.0	56.0	3.0	5.0	29.0	0.63	1.42	7.93	31.52	2.21	3.95	0.42	3.89
807E	135	7.5	56.0	3.5	4.5	28.5	0.46	1.09	7.97	32.81	2.05	2.84	0.42	3.77
807E	145	1.0	62.0	7.0	1.0	29.0	0.46	1.25	7.94	32.04	2.13	3.39	0.46	4.12
807E	155	2.0	62.0	4.5	3.5	28.0	0.67	1.23	8.19	32.21	2.04	3.03	0.44	3.79
807E	166	0.0	62.5	5.5	3.0	29.0	0.48	0.95	6.11	35.15	1.81	2.78	0.47	3.03
807E	185	6.5	59.0	4.5	2.0	28.0	0.28	0.75	7.88	33.34	1.90	2.48	0.52	3.91
807E	200	4.5	59.5	3.0	4.0	29.0	0.39	0.87	7.23	33.41	2.18	2.56	0.60	4.13
807E	206	2.5	76.5	2.5	2.5	16.0	0.0	1.07	7.77	32.48	1.98	3.87	0.41	4.03
807E	230	2.0	74.5	3.0	2.5	18.0	0.0	0.81	7.36	34.04	1.87	2.82	0.41	3.66
807E	265	16.1	48.7	2.0	7.5	25.6	0.28	1.26	8.73	31.45	2.05	3.31	0.52	4.12
807E	270	3.5	65.5	4.5	3.0	23.5	0.46	0.95	7.76	33.25	1.97	3.09	0.41	3.38
807E	280	6.5	62.0	4.5	6.5	20.5	0.25	1.22	8.44	31.43	2.13	3.64	0.50	4.11
807E	290	5.5	50.5	2.0	4.5	37.5	0.28	0.88	8.84	32.17	1.97	2.73	0.44	4.14
807E	300	5.1	69.1	3.7	2.9	19.1	0.19	1.03	9.14	31.94	2.08	2.59	0.59	3.78

Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
807E	310	5.6	70.9	3.9	3.4	16.2	0.10	1.15	8.99	31.08	2.02	3.31	0.49	4.57
808E	5	11.9	48.6	1.9	4.8	32.9	0.20	0.99	7.61	33.88	1.95	1.97	0.50	3.85
808E	25	45.5	34.5	4.0	2.0	14.0	0.33	0.86	7.00	35.09	1.87	1.77	0.36	3.28
808E	35	3.0	77.0	1.0	2.0	17.0	0.40	1.20	8.25	31.80	2.16	3.04	0.56	4.39
808E	45	7.0	72.5	3.5	2.0	15.0	0.74	1.61	7.52	32.[illegible]8	2.09	3.60	0.43	3.63
808E	55	1.0	65.0	6.5	5.0	22.5	0.69	1.40	7.37	33.18	2.10	3.22	0.37	3.02
808E	65	18.5	56.5	5.0	0.5	19.5	0.0	1.00	7.72	33.34	2.01	2.68	0.46	3.93
808E	75	44.5	31.0	1.5	3.5	19.5	0.0	0.98	7.41	33.93	1.90	2.60	0.51	3.63
808E	85	14.5	64.0	3.5	1.5	16.5	0.0	1.28	7.98	32.59	2.02	2.93	0.42	4.05
808E	95	17.5	44.0	6.5	6.5	25.5	0.33	1.10	7.70	33.13	2.06	2.78	0.48	3.72
808E	105	28.9	35.6	0.7	0.7	34.2	0.0	1.08	7.98	32.79	2.13	2.66	0.51	3.93
808E	125	16.5	49.5	5.0	6.5	22.5	0.38	0.47	8.12	33.73	2.03	1.34	0.40	4.39
808E	134	20.5	60.5	5.0	2.0	12.0	0.43	1.05	7.57	33.19	2.11	2.74	0.43	3.77
808E	185	11.5	52.5	3.5	7.0	25.5	0.36	1.11	7.88	32.75	2.07	3.27	0.49	3.50
808E	195	35.0	50.0	2.0	2.0	11.0	0.33	1.15	7.52	33.40	2.03	2.77	0.45	3.55
808E	206	15.0	59.5	4.0	3.5	18.0	0.25	0.67	7.72	34.46	1.94	1.45	0.42	3.62
808E	215	73.1	14.3	1.7	1.7	9.2	0.07	0.44	6.65	36.72	1.84	0.87	0.39	2.87
808E	320	8.5	51.5	4.0	7.5	28.5	0.96	0.94	7.08	34.16	1.90	2.75	0.39	2.79
808E	325	9.5	65.0	3.0	4.5	18.0	0.66	0.78	8.02	33.74	1.92	1.73	0.45	3.52
808E	330	9.5	65.0	4.5	3.5	17.5	0.37	1.20	8.18	32.09	2.12	3.23	0.50	3.99
808E	335	5.0	69.2	3.0	3.5	19.4	0.31	1.12	7.97	32.54	2.05	3.26	0.42	3.86
808E	340	4.0	52.5	2.0	6.6	34.8	0.64	1.2[illegible]	8.41	31.10	2.23	3.56	0.54	4.45
809E	15	2.5	51.5	3.5	4.5	38.0	0.0	1.05	8.90	32.14	2.03	2.64	0.43	3.84

Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
809E	25	3.5	68.0	2.0	4.5	22.0	0.28	0.70	7.75	34.42	1.87	1.36	0.48	3.72
809E	35	5.0	44.5	4.0	2.0	44.5	0.30	0.77	8.49	33.21	1.99	1.82	0.48	3.98
809E	45	4.0	69.5	1.0	2.0	23.5	0.20	0.85	7.94	33.91	1.87	1.83	0.48	3.69
809E	55	0.5	73.5	2.5	3.0	20.5	0.45	0.85	7.84	33.53	1.96	1.96	0.49	3.94
809E	65	6.5	68.5	2.0	1.0	22.0	0.48	1.04	7.99	33.00	2.03	2.03	0.47	4.20
809E	75	4.5	50.5	3.0	4.0	38.0	0.32	0.65	8.23	33.80	1.83	1.61	0.49	3.90
809E	85	11.4	69.6	5.1	0.6	13.3	0.15	0.70	7.78	34.57	1.91	1.24	0.57	3.62
809E	95	8.5	46.5	8.0	3.0	34.0	0.40	0.75	7.73	34.09	1.90	1.65	0.50	3.71
809E	105	1.0	79.0	2.0	1.0	17.0	0.22	0.71	7.30	34.67	1.90	1.49	0.51	3.88
809E	115	4.5	58.0	1.5	3.5	32.5	0.19	0.65	7.42	34.60	1.88	1.65	0.49	3.80
829E	10	23.5	49.5	3.0	2.0	22.0	0.0	0.72	8.33	33.53	2.09	1.51	0.49	4.19
828E	20	10.0	56.0	4.5	1.5	28.0	0.37	1.17	7.70	32.99	2.14	2.79	0.47	3.73
828E	30	3.0	66.5	4.5	2.0	24.0	0.60	1.28	7.51	32.60	2.09	3.10	0.45	3.94
828E	40	5.0	65.0	5.0	1.5	23.5	0.50	1.02	7.36	33.48	2.04	2.88	0.43	3.59
828E	50	0.5	69.0	3.0	3.5	24.0	0.58	1.27	7.53	32.63	2.28	2.96	0.47	3.93
828E	60	5.5	72.0	4.0	2.0	16.5	0.29	1.00	7.30	33.19	2.20	3.18	0.40	3.70
828E	70	6.0	61.0	3.5	5.5	24.0	0.29	1.10	6.63	34.20	2.12	3.07	0.35	3.23
829E	5	0.0	76.5	0.5	0.5	22.5	0.72	0.54	7.75	34.15	2.29	1.27	0.40	3.81
829E	10	5.6	70.6	2.1	4.9	16.8	0.51	1.25	6.51	33.99	1.92	3.43	0.30	3.35
829E	15	0.0	75.5	3.0	1.0	20.5	0.81	1.35	7.19	32.50	2.38	3.65	0.37	3.59
829E	20	0.5	83.0	4.0	1.0	11.5	0.51	0.44	7.50	33.59	2.25	2.01	0.72	4.22
829E	25	1.0	50.0	34.5	2.5	12.0	0.23	0.54	7.68	34.49	2.32	1.25	0.43	3.72
829E	30	1.0	81.0	3.5	2.5	12.0	0.39	1.21	6.94	33.23	2.20	3.45	0.33	3.81

Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
829E	35	1.5	80.5	5.0	0.5	12.5	0.25	1.30	7.32	33.01	1.97	3.84	0.33	3.45
829E	40	2.0	79.5	4.0	0.0	14.5	0.36	1.22	7.57	32.73	2.06	3.38	0.43	3.80
829E	45	0.0	74.5	7.5	0.5	17.5	0.51	1.49	7.44	32.44	2.22	3.51	0.46	3.65
829E	50	0.0	71.0	7.5	1.0	20.5	0.40	1.29	7.44	32.65	2.17	3.68	0.41	3.59
829E	55	2.0	78.0	4.0	1.5	14.5	0.56	1.90	7.71	30.94	2.28	4.35	0.43	4.20
829E	60	4.0	79.0	5.0	0.0	12.0	0.19	0.62	7.61	34.57	1.87	1.31	0.48	3.99
829E	65	0.5	74.0	3.0	12.0	10.5	0.81	0.30	8.75	32.29	1.78	2.46	0.49	3.92
829E	70	2.5	78.0	2.5	2.5	14.5	0.19	0.75	7.39	34.50	1.91	1.61	0.54	3.93
829E	75	1.5	72.0	5.5	1.5	19.5	0.0	0.62	7.23	35.08	1.88	1.57	0.44	3.69
829E	80	2.5	67.0	6.0	6.0	18.5	0.22	0.31	7.28	34.55	1.82	1.56	0.56	3.90
829E	85	7.5	67.5	2.5	2.5	20.0	0.10	0.57	7.47	34.89	1.84	1.28	0.55	3.80
829E	90	1.5	60.5	14.0	1.5	22.5	0.0	0.31	7.30	35.68	1.72	1.12	0.45	3.61
829E	95	1.5	72.5	3.5	3.5	19.0	0.34	1.60	7.82	31.95	2.20	3.39	0.46	4.07
830E	5	0.8	78.2	5.6	0.8	14.5	0.54	2.58	6.62	30.58	2.06	6.45	0.39	3.57
830E	10	12.1	63.6	7.6	0.8	15.9	0.44	1.15	7.64	33.15	2.03	2.52	0.37	3.92
830E	45	0.0	79.0	2.0	8.5	10.5	0.27	0.92	8.42	32.63	1.91	2.24	0.50	4.44
830E	65	2.0	69.0	3.5	2.5	23.0	0.25	1.93	7.55	31.46	2.20	4.44	0.45	3.84
830E	70	0.5	57.5	9.0	3.0	30.0	0.42	1.47	7.23	31.92	2.10	4.23	0.48	4.00
830E	75	2.0	53.5	23.0	4.0	17.5	0.47	1.29	7.23	32.88	1.99	3.66	0.42	3.64
830E	80	4.5	65.5	6.0	2.0	22.0	0.48	2.07	7.53	31.01	2.19	4.90	0.42	3.74
830E	85	0.0	64.5	8.0	3.5	24.0	0.42	0.95	7.15	34.01	1.96	2.96	0.40	3.13
830E	90	4.0	66.0	5.5	2.0	22.5	0.57	1.21	7.24	32.41	2.05	4.01	0.42	3.93
830E	95	0.5	73.5	5.5	1.5	19.0	0.55	1.18	7.15	32.73	2.05	3.77	0.41	3.69
830E	120	1.5	62.5	9.0	3.5	23.5	0.60	1.08	6.45	33.75	1.94	3.64	0.42	3.36

Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
830E	153	3.0	59.3	5.9	7.4	24.4	0.78	1.37	7.00	32.34	2.15	4.01	0.40	3.84
830E	164	2.5	66.0	6.5	1.0	24.0	0.42	1.14	7.64	33.09	2.10	2.79	0.39	3.71
831E	10	1.5	66.0	7.0	4.5	21.0	0.55	1.45	7.81	31.92	2.23	3.32	0.41	3.94
831E	40	2.5	52.0	23.5	5.0	17.0	0.72	1.52	7.05	32.20	2.14	4.23	0.40	3.51
831E	60	1.5	58.0	4.0	10.0	26.5	0.44	1.33	7.12	33.11	1.94	3.69	0.33	3.31
831E	80	2.0	56.0	6.5	7.5	28.0	0.50	1.39	6.98	32.81	2.07	4.03	0.40	3.52
831E	100	2.0	58.0	7.5	4.0	28.5	0.51	1.20	7.30	32.95	2.05	3.43	0.44	3.66
831E	140	0.5	64.0	12.0	1.5	22.0	0.65	1.02	7.45	32.63	2.15	3.31	0.48	3.88
831E	160	0.0	71.5	2.5	1.5	24.5	0.25	1.06	7.62	32.93	2.23	3.15	0.41	3.84
831E	180	1.5	62.5	6.0	3.5	26.5	0.58	1.04	8.22	32.83	2.14	2.57	0.39	3.47
831E	200	1.5	69.0	3.0	2.0	24.5	0.62	1.26	7.88	32.44	2.21	3.08	0.43	3.70
831E	220	2.0	55.5	4.0	4.0	34.5	0.77	1.28	7.72	32.44	2.26	3.09	0.42	3.70
831E	280	4.0	74.0	6.5	3.5	12.0	0.43	0.94	7.75	33.48	2.04	2.17	0.49	3.85
832E	10	2.5	73.8	3.5	4.5	15.8	0.58	1.35	7.19	33.29	2.09	3.04	0.38	3.39
832E	20	0.0	75.0	3.0	2.0	20.0	0.38	1.49	7.02	32.88	2.11	3.49	0.42	3.49
832E	30	13.5	61.5	3.0	1.0	21.0	0.56	1.59	7.80	32.27	2.09	3.27	0.41	3.68
832E	40	0.0	72.0	4.5	2.0	21.5	0.65	1.74	7.64	32.05	2.14	3.44	0.43	3.63
832E	50	3.0	61.9	6.5	3.0	25.6	0.32	1.30	8.50	32.10	2.17	2.64	0.51	3.87
832E	60	1.5	63.0	5.0	3.0	27.5	0.64	1.42	7.64	32.61	2.22	2.94	0.40	3.63
832E	70	1.0	70.0	8.5	1.5	19.0	0.40	1.19	7.04	34.11	2.07	2.79	0.34	3.00
832E	80	0.5	76.0	5.0	1.5	17.0	0.37	1.78	7.77	31.92	2.03	3.56	0.48	3.88
832E	90	1.5	64.0	8.5	3.0	23.0	0.47	1.53	7.07	33.19	2.11	3.38	0.43	3.25
832E	100	4.2	64.6	5.2	1.0	25.0	0.44	1.09	8.19	33.00	1.99	2.09	0.51	3.89

Hole/Depth	Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
	Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
832E 110	3.2	69.6	8.0	0.8	18.4	0.65	1.32	6.58	34.25	1.90	2.87	0.44	2.97
832E 120	1.9	74.5	0.9	2.8	19.8	0.61	0.98	7.88	33.20	2.03	2.20	0.52	3.63
832E 130	0.5	72.0	11.0	4.5	12.0	0.56	0.81	7.27	34.52	1.95	1.65	0.49	3.51
832E 140	6.0	71.0	5.5	6.5	11.0	0.32	0.69	7.02	35.48	1.83	1.08	0.42	3.52
832E 150	1.5	72.5	6.0	5.5	14.5	0.44	1.41	7.52	32.88	2.03	3.01	0.43	3.59
832E 160	2.0	60.0	4.5	4.5	29.0	0.35	1.45	7.96	32.16	2.17	3.02	0.46	3.85
832E 170	7.5	54.5	2.5	6.0	29.5	0.95	1.34	8.12	32.65	2.32	2.47	0.39	3.19
832E 180	1.5	68.0	4.0	2.5	24.0	0.18	1.20	8.34	32.35	2.11	2.99	0.41	3.90
832E 190	1.0	57.5	4.5	5.5	31.5	0.43	0.82	8.27	33.15	1.99	2.01	0.50	3.95
832E 198	5.0	71.0	0.5	1.0	22.5	0.46	1.12	8.51	32.16	2.09	2.55	0.49	3.99
833E 10	74.5	17.0	1.5	1.5	5.5	0.26	1.28	7.13	33.35	2.12	3.19	0.39	3.65
833E 20	40.5	45.0	1.0	0.5	13.0	0.18	1.14	7.88	33.15	2.12	2.15	0.46	4.14
833E 30	4.5	63.5	2.0	6.5	23.5	0.0	1.11	7.64	33.53	2.14	2.45	0.51	3.73
833E 40	26.0	54.0	4.0	2.5	13.5	0.25	1.23	7.61	32.75	2.10	3.03	0.49	4.06
833E 50	84.0	10.0	3.0	1.5	1.5	0.28	1.25	7.29	33.19	2.09	3.14	0.41	3.76
833E 60	48.5	33.0	3.0	1.0	14.5	0.44	1.03	7.33	33.70	2.18	2.49	0.42	3.60
833E 70	14.2	58.9	7.1	1.4	18.4	0.27	1.22	7.43	33.15	2.05	2.96	0.41	3.88
833E 80	38.5	46.5	2.0	1.0	12.0	0.45	1.28	7.91	32.34	2.20	3.05	0.38	4.05
833E 90	28.5	45.5	4.5	2.5	19.0	0.0	0.92	7.51	33.96	1.95	2.46	0.40	3.76
833E 100	37.5	44.0	2.5	2.0	14.0	0.0	1.00	7.66	33.58	1.95	2.53	0.50	3.71
833E 115	4.0	59.0	8.0	8.0	21.0	0.12	0.58	7.15	34.91	1.99	1.98	0.37	3.41
833E 125	1.0	69.5	4.0	4.0	21.5	0.39	1.73	7.03	32.50	2.07	4.34	0.45	3.25
833E 135	10.5	63.5	5.0	8.5	12.5	0.61	2.32	7.22	30.89	2.09	5.14	0.43	3.70
833E 200	12.5	59.0	1.0	2.5	25.0	0.51	1.62	7.83	31.39	2.18	4.09	0.43	3.94

Hole/Depth		Grain Lithology of 1-2mm Fraction (%)*					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
833E	210	22.5	47.0	1.5	1.0	28.0	0.13	0.69	7.76	34.18	2.03	1.56	0.50	3.95
833E	220	13.0	53.0	3.0	1.0	30.0	0.27	0.69	7.64	33.90	1.99	1.47	0.49	4.47
833E	230	47.0	31.0	2.0	3.0	17.0	0.15	0.70	7.76	34.16	1.95	1.49	0.44	4.14
833E	240	5.4	65.9	3.0	4.8	21.0	0.22	0.83	8.03	33.41	2.01	1.83	0.54	4.13
833E	250	6.0	54.0	3.0	0.5	36.5	0.10	0.96	8.34	32.90	2.02	2.28	0.45	4.03
833E	260	11.5	53.5	3.5	0.5	31.0	0.38	0.75	8.27	32.88	2.14	2.29	0.49	4.13
833E	270	29.0	38.5	2.5	6.5	23.5	0.14	0.85	8.40	32.84	1.97	2.38	0.48	4.20
833E	280	48.0	47.0	0.0	1.0	4.0	0.20	0.69	8.05	33.69	1.92	2.00	0.54	3.85
834E	5	12.2	55.1	3.1	3.1	26.5	0.0	0.80	7.55	34.22	1.88	2.01	0.46	3.89
834E	15	3.0	69.0	3.0	1.5	23.5	0.0	0.76	7.55	33.94	1.97	2.35	0.45	3.78
834E	25	0.5	73.5	4.0	1.0	21.0	0.71	1.41	7.34	32.83	2.10	3.40	0.44	3.32
834E	35	4.0	58.0	3.0	6.0	29.0	0.21	0.73	6.99	34.67	1.91	2.36	0.41	3.39
834E	45	1.5	63.0	5.5	4.5	25.5	0.24	1.15	6.82	33.81	1.91	3.34	0.44	3.31
834E	55	2.5	65.0	5.0	2.5	25.0	0.33	1.30	7.35	32.88	2.04	3.42	0.45	3.66
834E	65	6.5	53.5	6.0	5.0	29.0	0.48	1.17	7.54	32.54	2.18	3.32	0.44	4.04
834E	85	5.0	65.5	8.0	2.0	19.5	0.38	1.17	7.56	32.64	2.17	3.45	0.38	3.89
834E	95	19.0	54.5	4.5	0.5	21.5	0.31	1.10	7.89	32.87	2.05	2.82	0.39	3.86
834E	160	1.0	59.0	8.5	6.5	25.0	0.29	0.83	7.58	33.30	2.06	2.79	0.53	3.89
834E	170	7.0	64.0	4.0	2.0	23.0	0.13	0.63	7.46	34.36	1.92	2.18	0.46	3.65
834E	180	2.0	66.5	1.0	4.5	26.0	0.24	0.72	7.75	33.89	1.93	1.96	0.53	3.91
834E	190	4.5	64.5	3.5	2.5	25.0	0.59	0.70	7.40	34.14	1.99	1.98	0.46	3.69
835E	10	3.0	69.0	1.5	1.0	25.5	0.44	1.08	8.14	33.01	2.01	2.00	0.50	4.00
835E	30	13.5	61.0	3.5	1.5	20.5	0.26	1.11	7.94	32.71	2.03	2.42	0.47	4.20

Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
835E	40	3.5	59.5	5.0	5.5	26.5	0.38	1.16	8.14	32.91	2.25	2.51	0.37	3.48
835E	50	14.0	51.0	3.5	3.5	28.0	0.44	1.25	8.30	32.60	2.28	2.49	0.37	3.68
835E	60	14.5	46.0	14.0	5.0	20.5	0.33	1.05	8.42	32.03	1.89	2.84	0.51	4.87
835E	70	26.5	43.5	3.5	2.5	24.0	0.72	2.53	7.01	30.85	2.28	5.52	0.38	3.26
835E	80	1.5	73.5	2.0	2.5	20.5	0.43	1.39	6.99	33.75	1.96	2.92	0.46	3.26
835E	90	23.5	46.5	4.0	5.5	20.5	0.39	1.03	7.76	33.32	2.06	2.53	0.41	3.70
835E	100	22.5	57.5	2.5	3.5	14.0	0.38	1.04	7.55	33.68	2.25	2.47	0.40	3.35
835E	150	4.5	53.5	7.0	3.5	31.5	0.50	1.44	6.61	33.81	2.05	3.37	0.33	3.13
835E	160	3.7	65.2	3.7	3.0	24.4	0.65	2.92	6.92	30.20	2.09	6.62	0.33	3.09
835E	170	5.5	58.5	1.0	2.0	33.0	0.85	2.35	6.73	31.58	2.20	5.15	0.37	3.06
835E	180	9.5	56.5	8.5	2.0	23.5	0.36	1.38	7.49	33.06	2.14	2.99	0.41	3.51
836E	30	4.5	55.5	12.5	4.5	23.0	0.56	1.13	9.04	31.64	2.36	2.76	0.45	3.61
836E	60	3.0	55.0	5.5	5.0	31.5	0.21	1.26	7.63	33.29	2.04	2.93	0.39	3.48
836E	100	21.3	45.7	4.7	3.1	25.2	0.41	1.01	8.25	33.01	2.08	2.25	0.41	3.72
836E	140	1.5	56.0	7.5	6.5	28.5	0.43	1.14	7.76	32.89	2.20	2.73	0.39	3.84
836E	200	1.8	61.5	2.8	0.0	33.9	0.44	1.42	8.48	31.71	2.18	3.15	0.45	3.93
952E	10	1.5	80.0	2.0	0.0	16.5	0.31	1.25	8.84	31.77	2.21	2.65	0.45	4.09
952E	20	3.5	65.0	6.0	4.0	21.5	0.42	0.86	8.44	33.39	1.97	1.89	0.44	3.56
952E	24	4.5	71.0	8.0	1.5	15.0	0.24	0.97	7.86	33.82	1.99	1.83	0.43	3.79
952E	30	31.0	44.0	3.0	3.0	19.0	0.51	1.27	8.42	31.91	2.09	2.59	0.51	4.40
952E	40	36.5	37.0	3.5	6.0	17.0	0.25	1.01	7.93	33.32	2.03	1.93	0.51	3.97
952E	65	4.5	72.5	1.5	2.0	19.5	0.44	1.28	7.73	32.71	2.17	3.07	0.51	3.58
952E	70	1.0	67.5	2.5	2.5	26.5	0.46	1.24	7.81	32.87	2.08	2.82	0.42	3.70

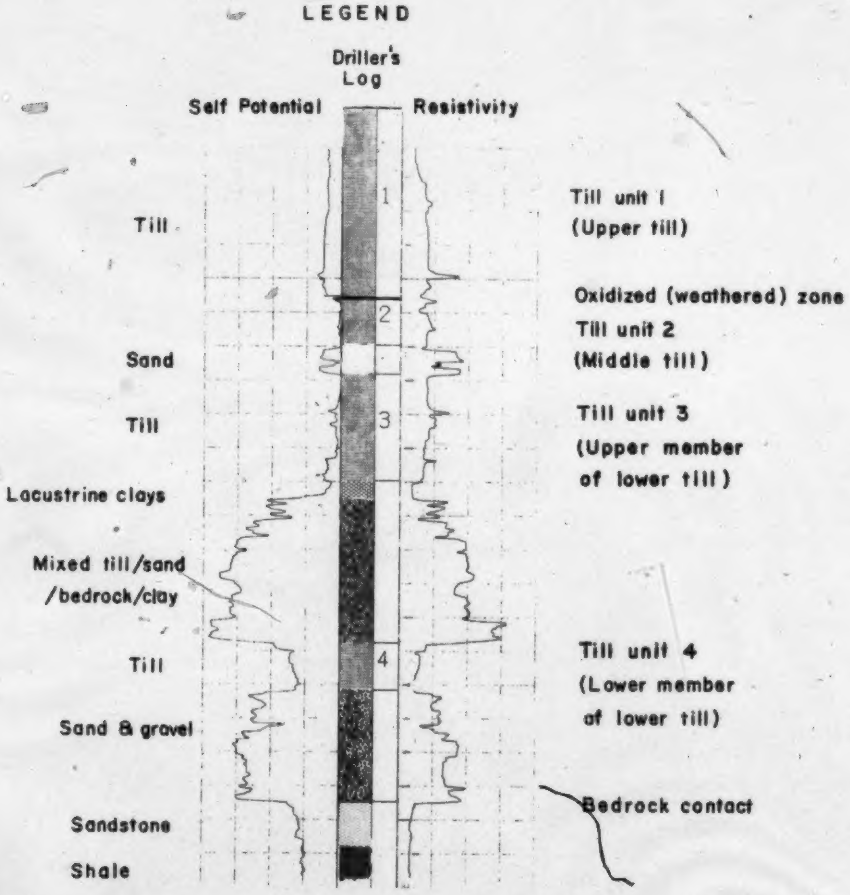
Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
952E	75	2.0	65.5	7.0	2.0	23.5	0.44	1.36	7.83	32.49	2.13	3.06	0.45	3.64
952E	80	15.5	62.5	2.5	1.0	18.5	0.39	1.20	7.57	32.96	2.09	3.04	0.44	3.73
952E	95	1.5	63.0	4.0	3.5	28.0	0.52	1.28	8.37	31.87	2.15	2.79	0.43	4.23
952E	105	3.5	70.5	4.5	5.0	16.5	0.32	0.64	7.62	34.25	1.88	1.42	0.49	4.08
952E	110	5.5	57.5	6.5	9.5	21.0	0.45	1.27	7.97	32.45	2.13	2.80	0.44	3.95
953E	6	3.4	75.7	0.7	0.7	19.6	0.38	0.88	8.16	33.19	1.83	2.11	0.46	4.12
953E	60	2.0	42.0	9.5	22.5	24.0	0.33	0.79	7.81	33.82	1.96	1.96	0.44	3.84
953E	70	1.5	65.0	3.0	4.0	26.5	0.47	1.09	8.16	32.80	2.07	2.14	0.45	4.04
953E	80	0.0	66.0	1.5	2.5	30.0	0.11	0.45	7.26	35.30	1.79	1.46	0.49	3.40
953E	90	3.5	70.0	2.5	2.5	21.5	0.22	0.73	7.96	33.96	1.97	1.69	0.48	3.81
953E	100	3.5	34.0	1.5	2.0	59.0	0.0	0.58	7.71	34.44	1.86	1.54	0.47	3.82
953E	105	2.0	65.3	5.5	3.5	23.6	0.29	1.08	7.98	33.26	2.08	2.57	0.37	3.52
953E	110	4.5	57.5	2.2	3.0	32.8	0.0	0.75	8.47	33.25	1.89	1.69	0.74	4.10
953E	120	3.8	61.7	1.5	1.5	31.6	0.0	0.52	7.65	34.65	1.83	1.58	0.51	3.85
953E	130	5.5	31.0	3.0	1.5	59.0	0.0	0.68	8.26	33.98	1.91	1.54	0.48	3.77
953E	140	3.7	55.9	2.5	4.3	33.5	0.17	0.62	7.75	34.60	1.95	1.38	0.45	3.66
953E	151	5.2	57.4	8.7	3.5	25.2	0.42	1.02	8.12	32.98	1.98	2.19	0.56	3.97
953E	160	20.0	52.9	3.6	3.6	20.0	0.15	0.65	6.96	35.19	1.75	1.84	0.37	3.62
956E	10	0.0	76.5	5.5	1.0	17.0	0.67	1.37	7.98	32.17	2.23	3.17	0.36	3.78
956E	20	9.5	56.0	4.5	4.0	26.0	0.23	0.62	8.01	34.21	1.84	1.85	0.41	3.52
956E	30	10.0	54.0	7.0	4.0	25.0	0.29	0.94	8.46	32.74	1.97	2.32	0.44	4.04
956E	40	14.0	47.5	3.5	6.5	28.5	0.41	1.18	7.90	32.12	1.92	3.20	0.49	4.39
956E	50	13.0	55.5	2.0	1.5	28.0	0.23	1.05	7.83	32.93	1.85	2.57	0.51	4.36

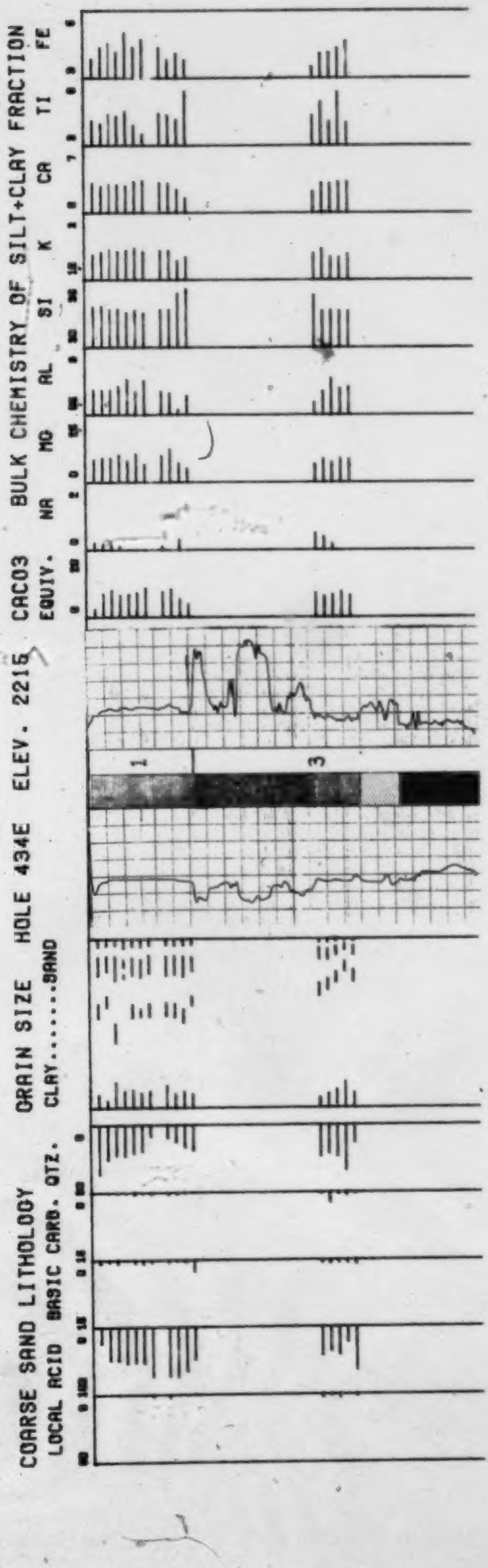
Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
956E	60	6.5	62.0	2.5	4.5	24.5	0.0	1.00	8.31	33.29	1.26	2.30	0.45	4.28
956E	70	42.5	32.5	2.0	2.5	20.5	0.0	0.70	7.06	34.35	1.90	1.88	0.42	4.54
956E	80	9.0	59.2	4.0	2.5	25.4	0.0	0.77	8.05	33.28	1.99	2.15	0.51	4.39
956E	90	3.5	63.0	3.0	5.5	25.0	0.22	0.97	8.38	32.02	1.93	2.73	0.53	4.87
956E	100	3.0	64.0	3.0	3.5	26.5	0.25	0.80	8.11	33.11	1.89	2.44	0.45	4.17
956E	110	9.5	56.0	3.5	4.5	26.5	0.38	1.11	7.58	33.18	2.00	2.54	0.45	3.89
956E	120	10.0	54.5	7.0	3.5	25.0	0.37	1.02	8.37	32.51	1.94	2.56	0.48	4.17
956E	130	5.5	65.0	2.5	3.5	23.5	0.49	1.09	8.11	32.37	1.86	2.69	0.48	4.46
956E	140	9.0	60.5	5.5	5.0	20.0	0.46	1.22	8.60	31.63	1.94	2.85	0.47	4.60
956E	150	7.5	61.0	3.5	3.0	25.0	0.36	1.03	8.65	32.25	1.94	2.40	0.50	4.31
956E	160	16.5	57.5	1.5	4.5	20.0	0.23	0.69	8.25	33.87	1.83	1.75	0.37	3.73
956E	170	6.0	60.3	4.0	6.5	23.1	0.57	2.07	6.62	32.12	1.93	4.98	0.39	3.26
956E	200	4.5	77.5	1.0	1.0	16.0	0.31	0.68	7.29	35.12	1.82	1.44	0.42	3.36
956E	210	8.2	62.8	7.1	3.1	18.9	0.42	0.87	7.57	34.14	1.92	1.80	0.47	3.66
956E	220	5.5	57.0	4.5	3.0	30.0	0.20	0.45	7.69	35.29	1.81	1.13	0.36	3.32
956E	233	9.5	64.0	2.5	4.5	19.5	0.53	0.71	8.35	33.09	1.66	2.06	0.54	4.07
956E	240	10.0	58.0	4.5	5.0	22.5	1.52	0.75	8.07	32.02	1.84	2.66	0.50	4.32
956E	250	13.5	52.0	6.0	3.0	25.5	0.39	0.56	7.49	34.55	1.79	1.38	0.49	3.82
956E	260	8.5	57.0	8.5	1.5	24.5	0.46	0.64	7.90	33.55	1.97	1.78	0.50	4.13
956E	270	3.5	62.0	3.5	0.5	30.5	0.64	0.60	7.60	33.72	1.95	1.65	0.51	3.98
956E	280	11.0	55.5	5.0	3.0	25.5	0.47	0.53	7.61	33.95	1.85	1.66	0.40	4.30
956E	290	11.5	58.0	4.5	3.0	23.0	0.22	0.72	8.08	33.42	1.97	1.79	0.53	4.34
956E	300	13.5	47.5	6.5	3.0	29.5	0.0	0.33	7.09	35.40	1.77	1.40	0.45	3.98
957E	20	3.0	63.0	8.0	6.0	20.0	0.42	1.32	8.05	31.64	2.14	3.16	0.47	4.20

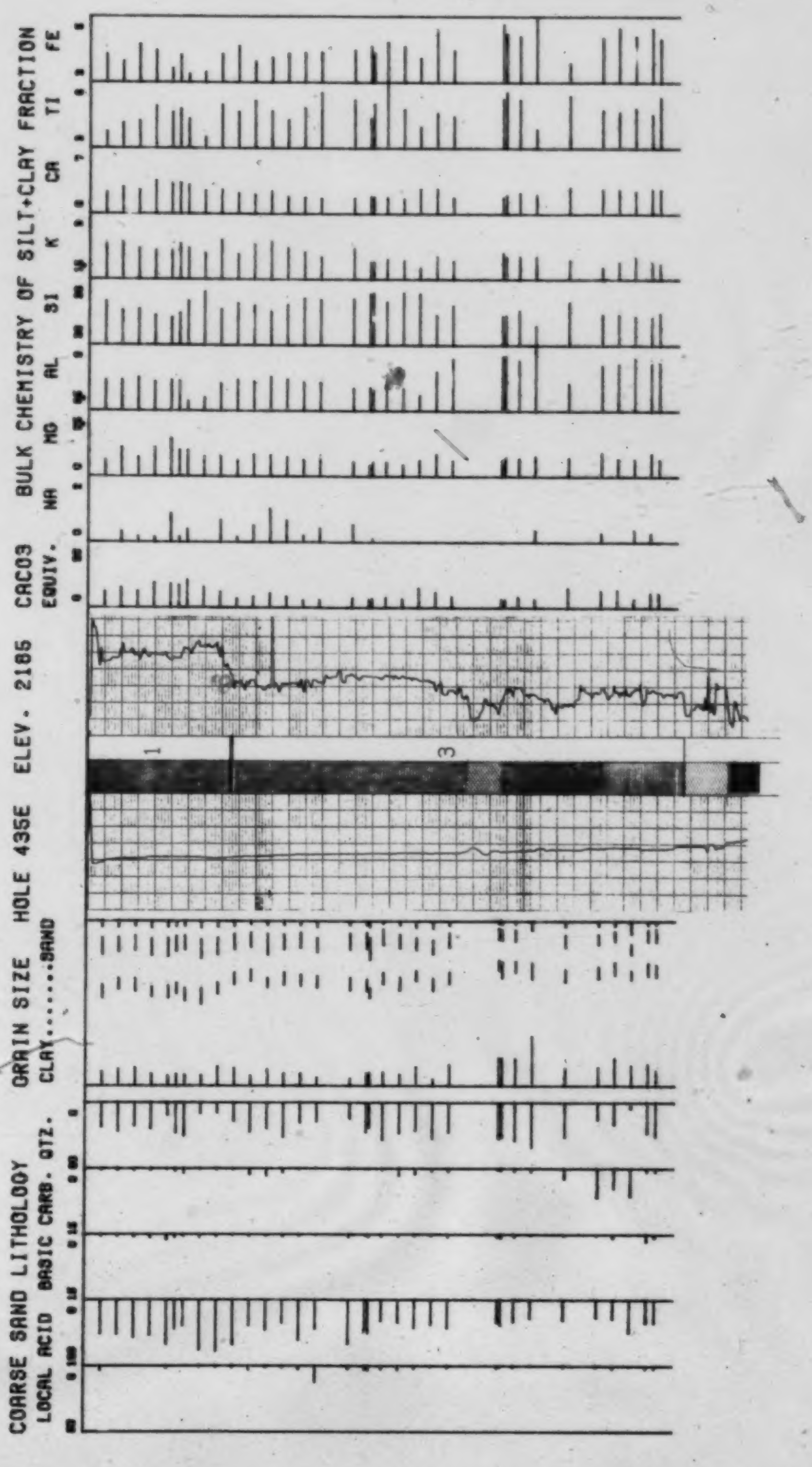
Hole/Depth		Grain Lithology of 1-2mm Fraction (%)					Bulk Chemistry of Silt and Clay Fraction (%)							
		Local	Acid	Basic	Carb.	Qtz.	Na	Mg	Al	Si	K	Ca	Ti	Fe
957E	30	23.5	54.5	3.5	2.5	16.0	0.42	1.41	7.73	32.49	2.10	3.03	0.43	3.90
957E	40	3.2	47.4	2.6	33.2	13.7	0.45	0.96	8.12	31.40	1.96	2.83	1.17	5.09
957E	50	15.5	59.5	4.0	1.5	19.5	0.53	0.57	7.16	35.15	1.87	1.79	0.32	3.14
957E	60	55.5	25.0	2.0	0.5	17.0	0.16	0.37	6.59	35.98	1.65	0.78	0.54	3.73
957E	70	36.0	32.5	2.0	11.5	18.0	0.0	0.42	7.30	35.72	1.73	0.94	0.46	3.41
957E	80	6.5	68.8	4.8	3.2	16.7	0.70	0.68	8.01	33.35	1.79	1.81	0.54	4.14
958E	10	11.0	62.0	3.0	4.0	20.0	0.17	0.99	8.11	32.85	2.02	2.50	0.48	4.12
958E	20	51.7	30.2	2.6	0.9	14.7	0.0	0.85	7.95	33.66	1.93	1.90	0.45	4.23
958E	30	6.0	58.7	5.3	2.7	27.3	0.19	0.76	8.20	33.72	1.94	1.69	0.50	3.76
958E	40	43.5	34.5	0.5	0.5	21.0	0.27	0.84	7.65	33.99	1.87	1.84	0.48	3.82
958E	50	3.7	62.0	2.5	5.5	26.4	0.42	0.94	7.90	33.01	2.53	2.69	0.39	3.53
958E	57	7.7	56.4	1.9	0.6	33.3	0.52	1.09	7.78	32.96	2.08	2.38	0.56	3.85

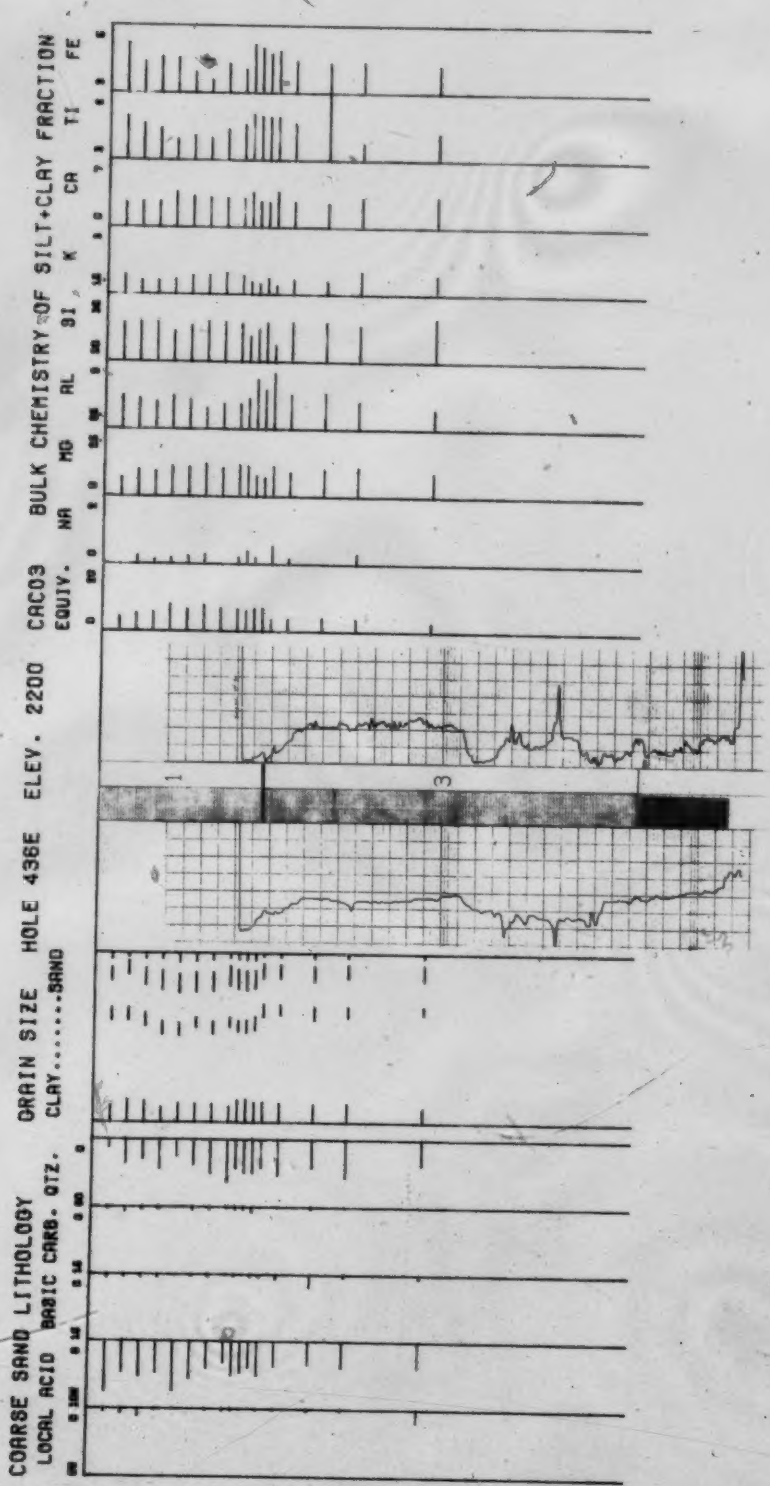
APPENDIX 4

Plots of each drill hole, showing all analyzed variables, lithology and stratigraphic interpretation.


LEGEND
Driller's Log
Self Potential
Resistivity
Till
Sand
Till
Lacustrine clays
Mixed till/sand /bedrock/clay
Till
Sand & gravel
Sandstone
Shale
1
2
3
4
Till unit 1 (Upper till)
Oxidized (weathered) zone
Till unit 2 (Middle till)
Till unit 3 (Upper member of lower till)
Till unit 4 (Lower member of lower till)
Bedrock contact


COARSE SAND LITHOLOGY
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY......SAND
HOLE 434E
ELEV. 2215
1
3
CACO3 EQUIV.
NA
MG
AL
SI
K
CA
TI
FE
BULK CHEMISTRY OF SILT+CLAY FRACTION


BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MG
AL
SI
K
CA
TI
FE
CACO3
EQUIV.
HOLE 435E
ELEV. 2185
1
3
GRAIN SIZE
CLAY......SAND
COARSE SAND LITHOLOGY
LOCAL
ACID
BASIC
CARB.
QTZ.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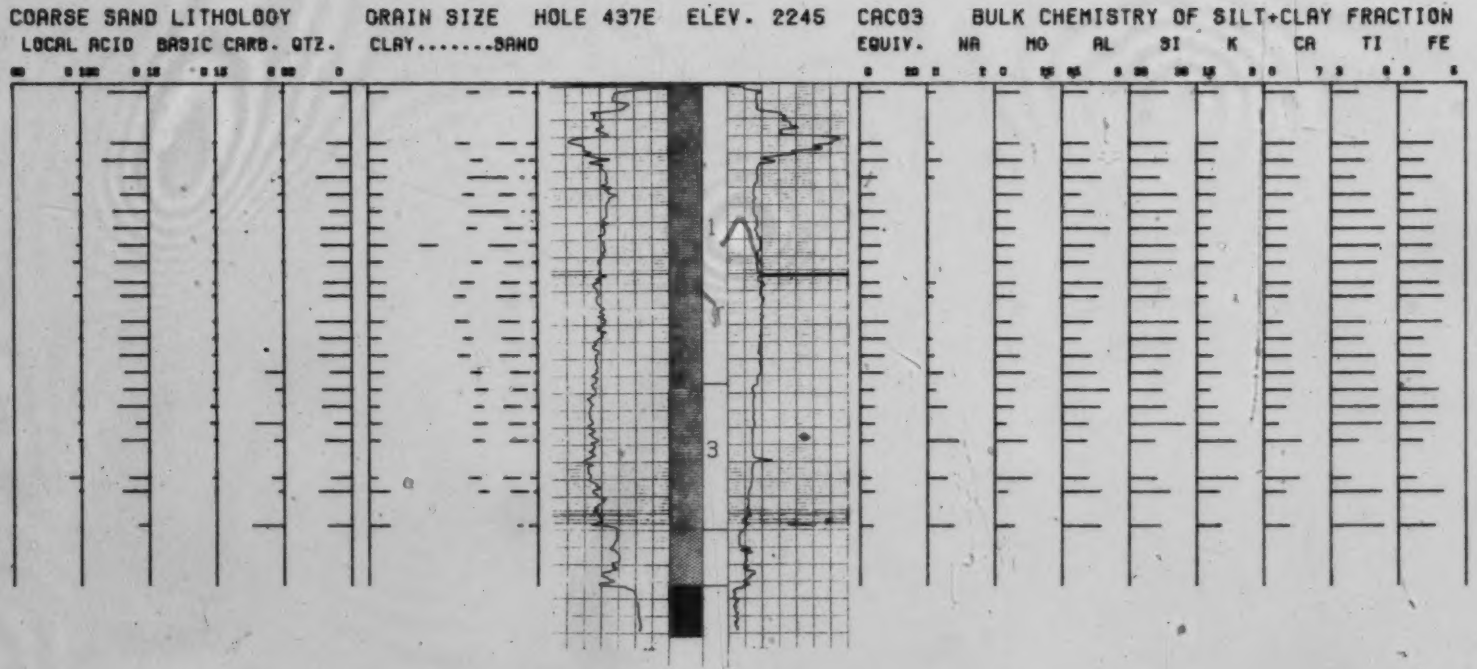
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY.......SAND
HOLE 436E
ELEV. 2200
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA MG AL SI K CA TI FE
1
3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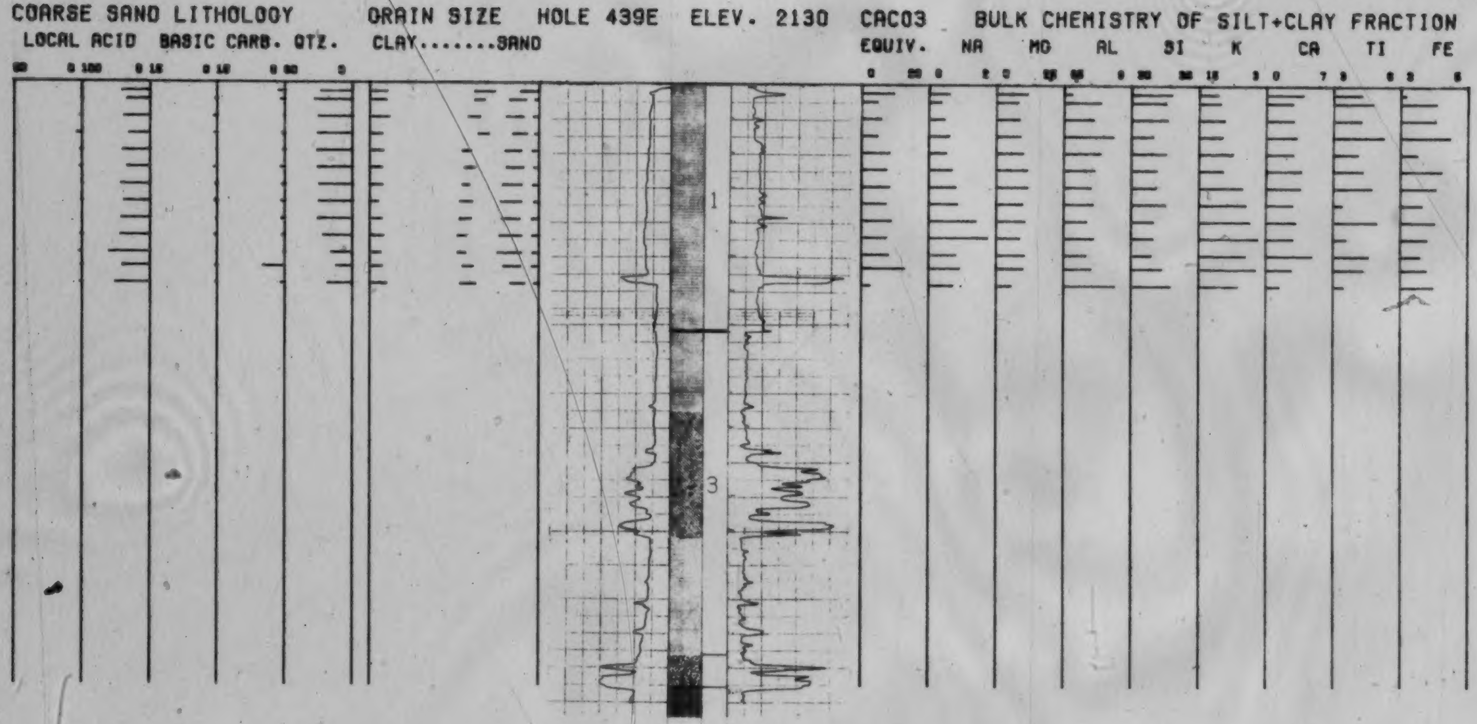
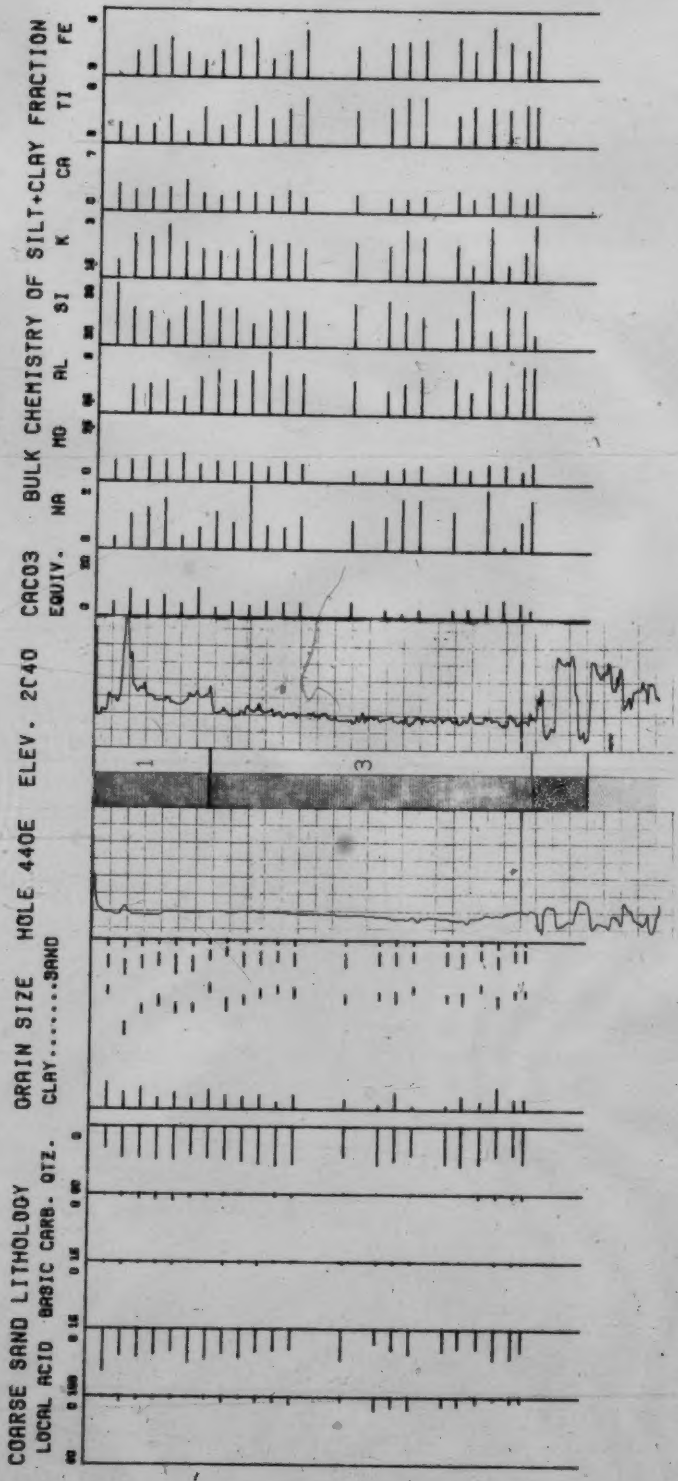
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY.......SAND
HOLE 437E ELEV. 2245
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA MG AL SI K CA TI FE
1
3


COARSE SAND LITHOLOGY
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY.......SAND
HOLE 439E
ELEV. 2130
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MG
AL
SI
K
CA
TI
FE
1
3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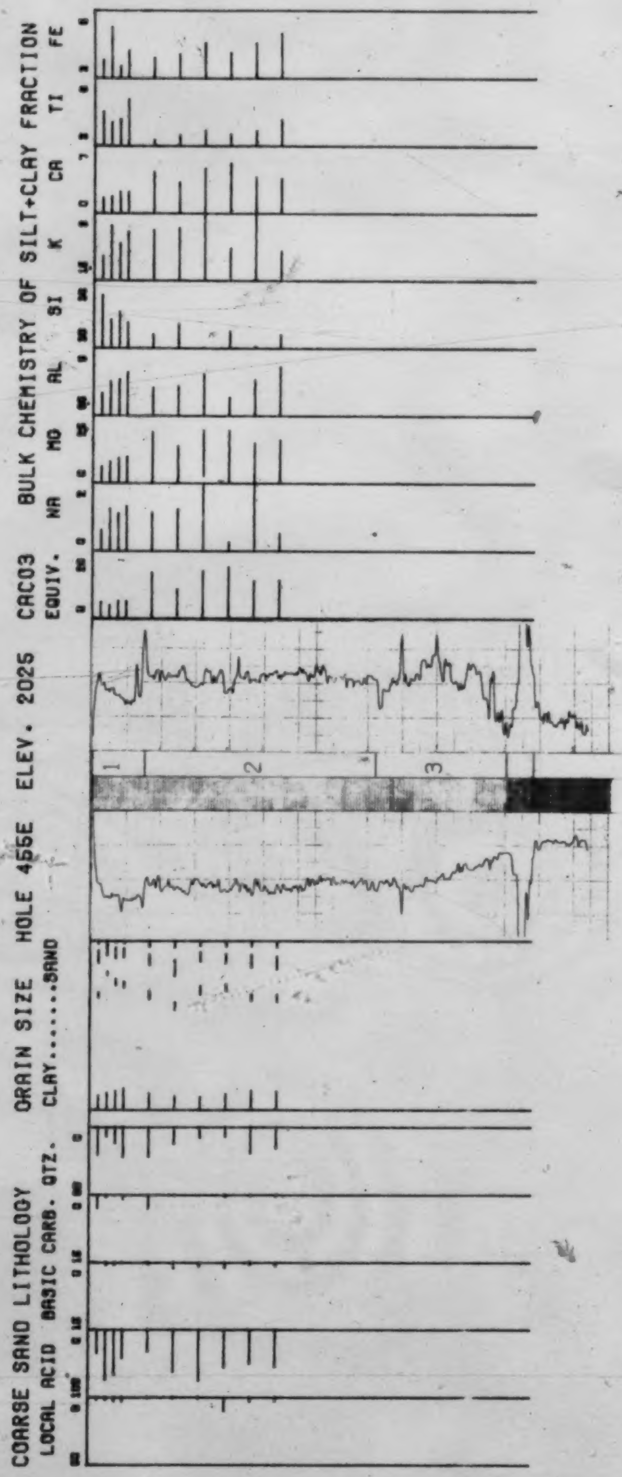
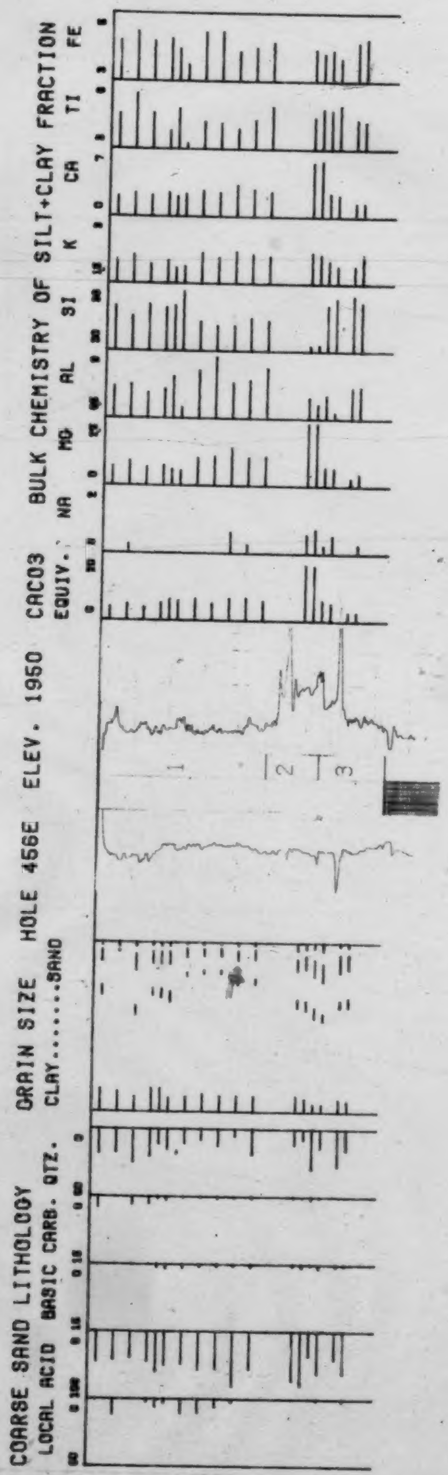
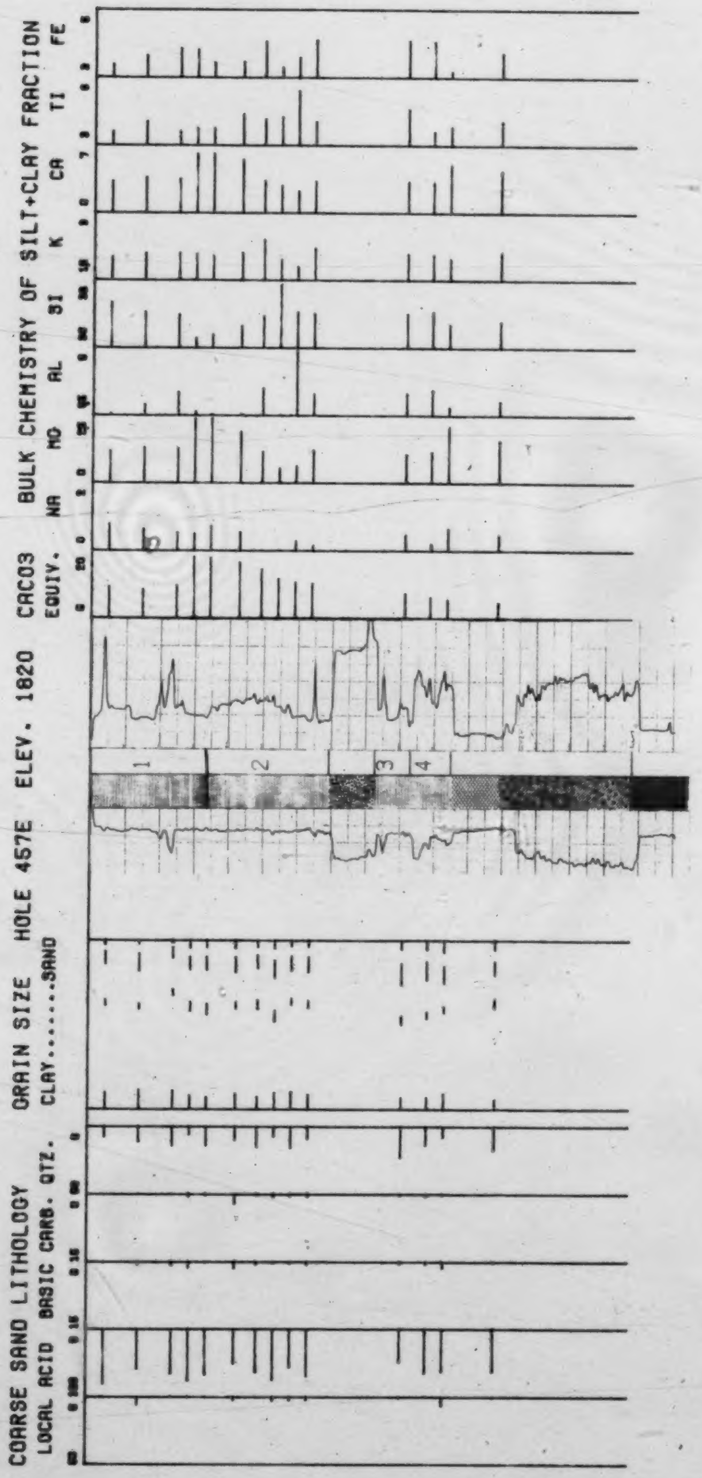
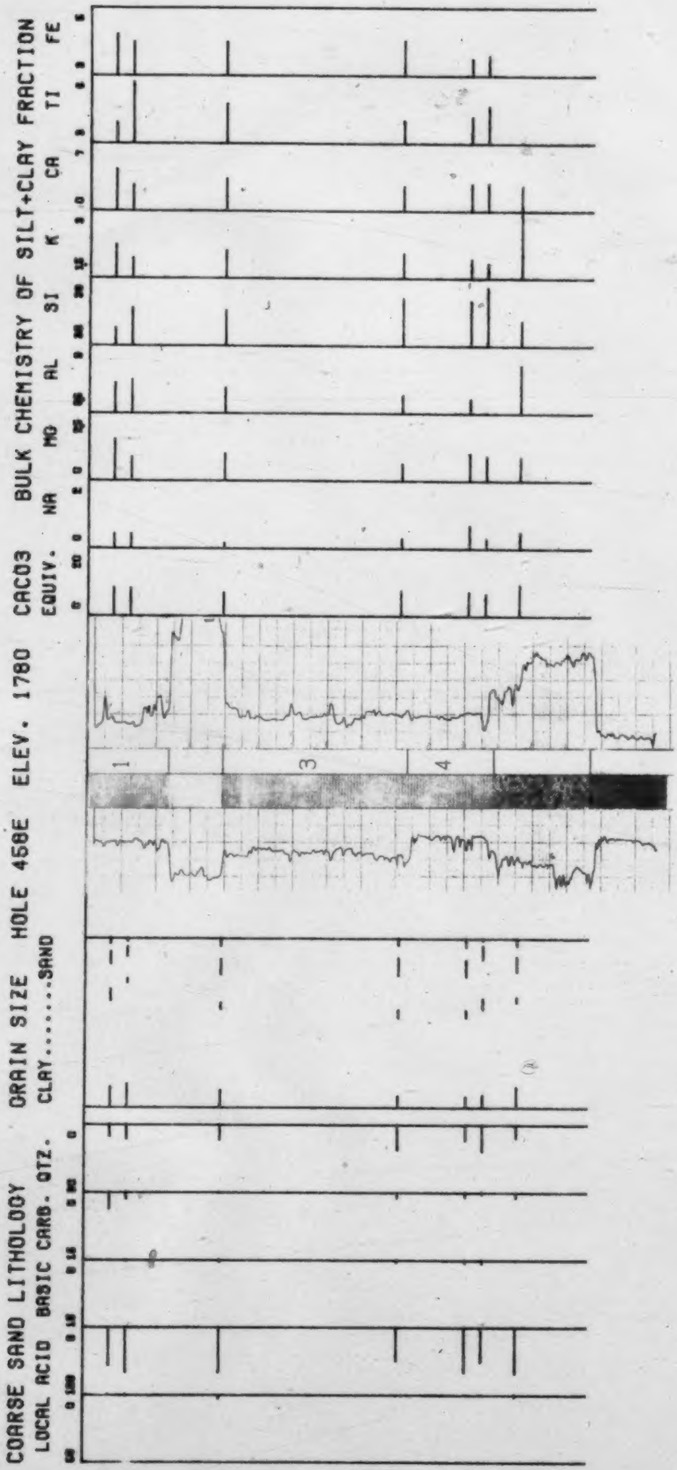
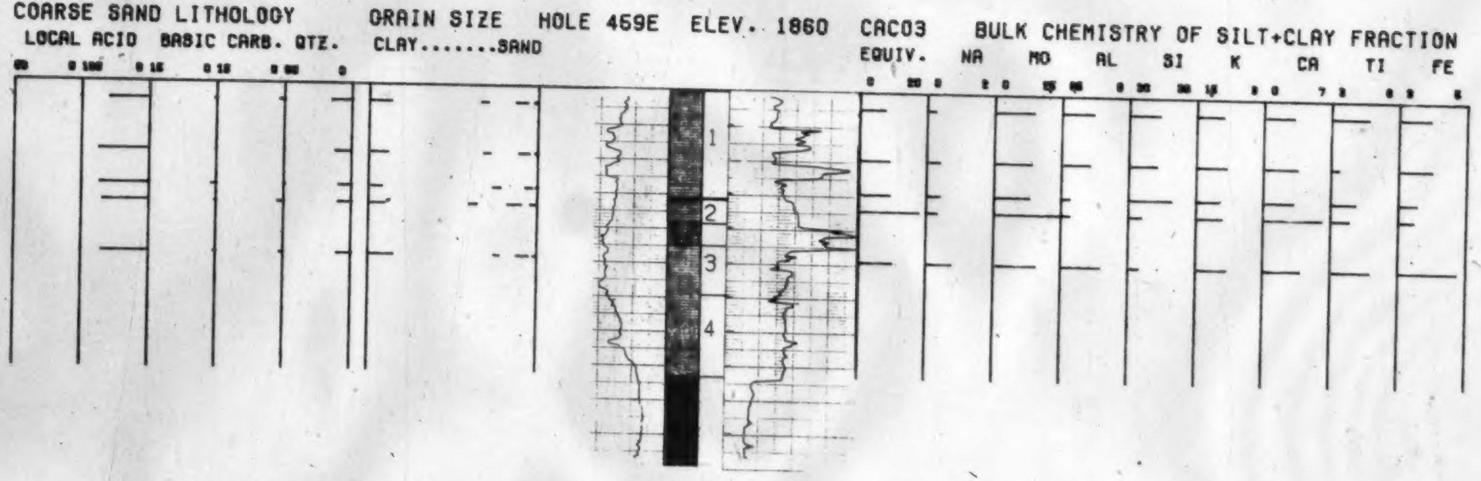
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY......SAND
HOLE 440E
ELEV. 2040
1
3
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MG
AL
SI
K
CA
TI
FE


COARSE SAND LITHOLOGY
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY......SAND
HOLE 455E ELEV. 2025
1
2
3
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MG
AL
SI
K
CA
TI
FE


COARSE SAND LITHOLOGY
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY......SAND
HOLE 456E ELEV. 1950
1
2
3
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MG
AL
SI
K
CA
TI
FE


COARSE SAND LITHOLOGY
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY......SAND
HOLE 457E ELEV. 1820
1
2
3
4
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA MG AL SI K CA TI FE


COARSE SAND LITHOLOGY
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY......SAND
HOLE 458E
ELEV. 1780
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MG
AL
SI
K
CA
TI
FE
1
3
4


COARSE SAND LITHOLOGY
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY.......SAND
HOLE 459E ELEV. 1860
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MO
AL
SI
K
CA
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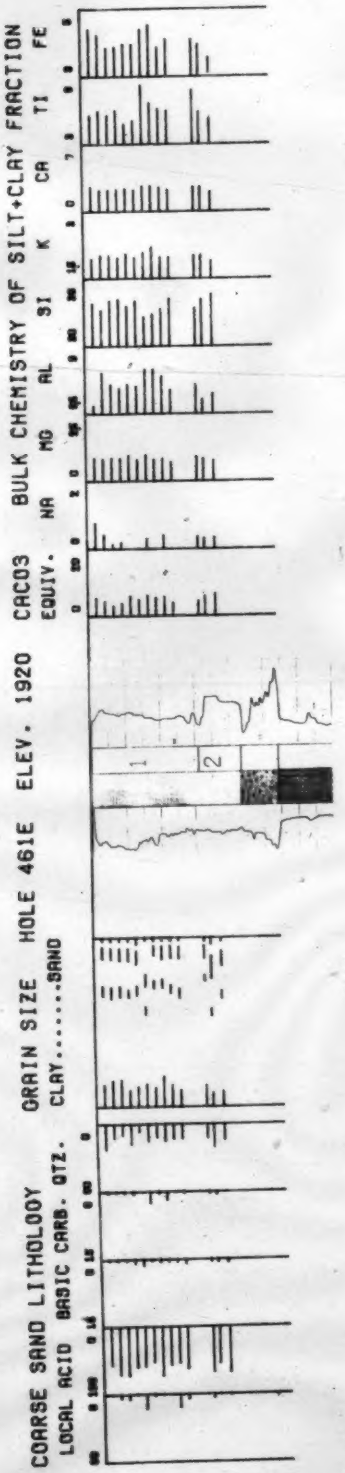
FE
1
2
3
4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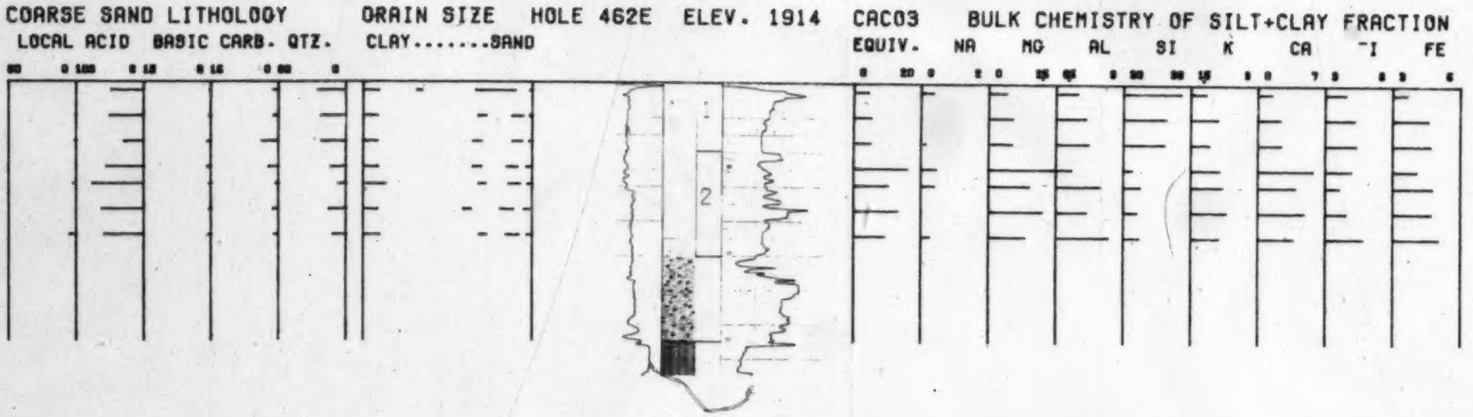
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY......SAND
HOLE 461E ELEV. 1920
1
2
CACO3 EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA MG AL SI K CA TI FE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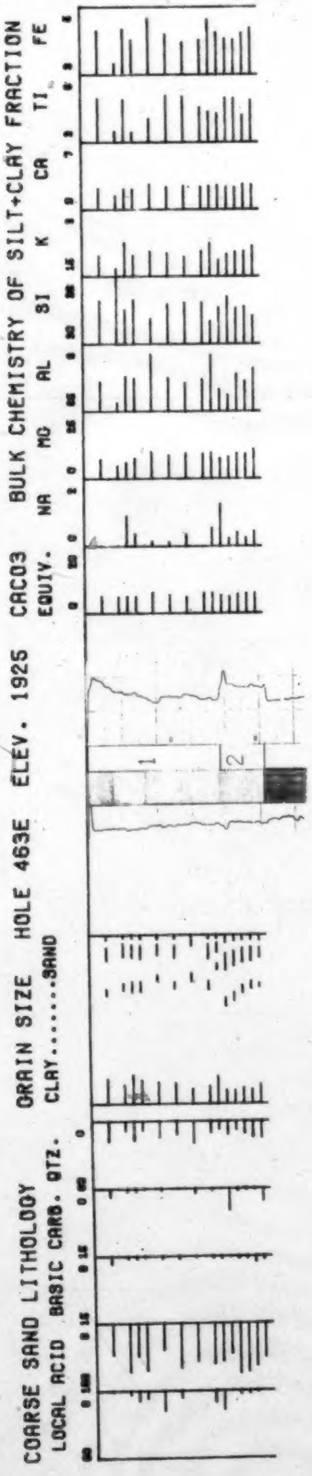
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY.......SAND
HOLE 462E
ELEV. 1914
1
2
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MG
AL
SI
K
CA
TI
FE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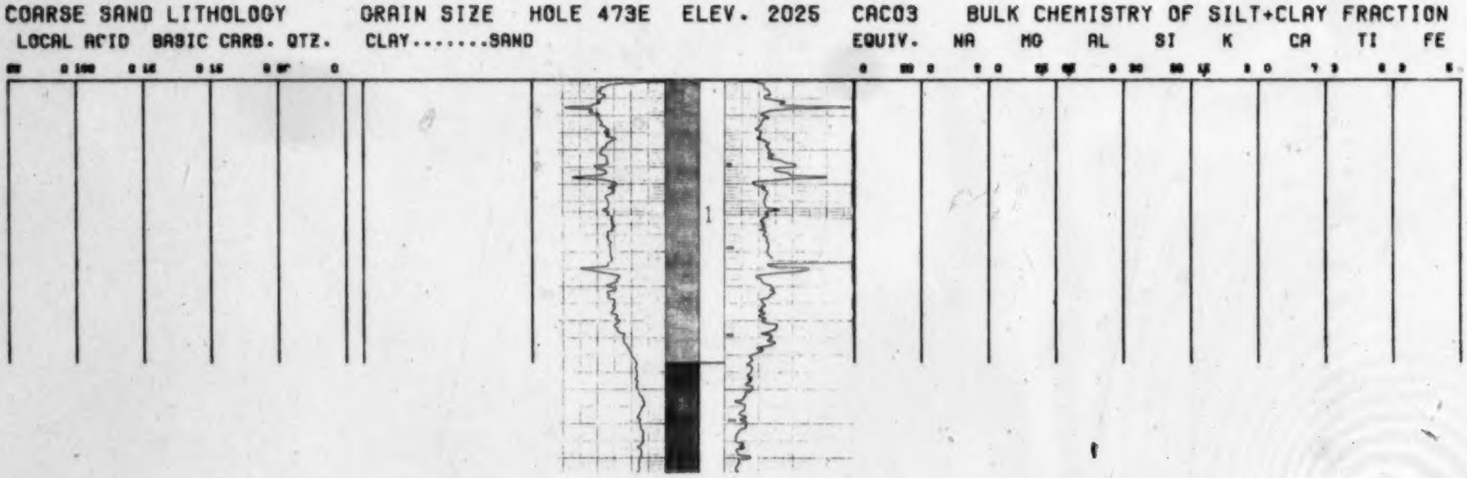
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY......SAND
HOLE 463E ELEV. 1925
1
2
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA MG AL SI K CA TI FE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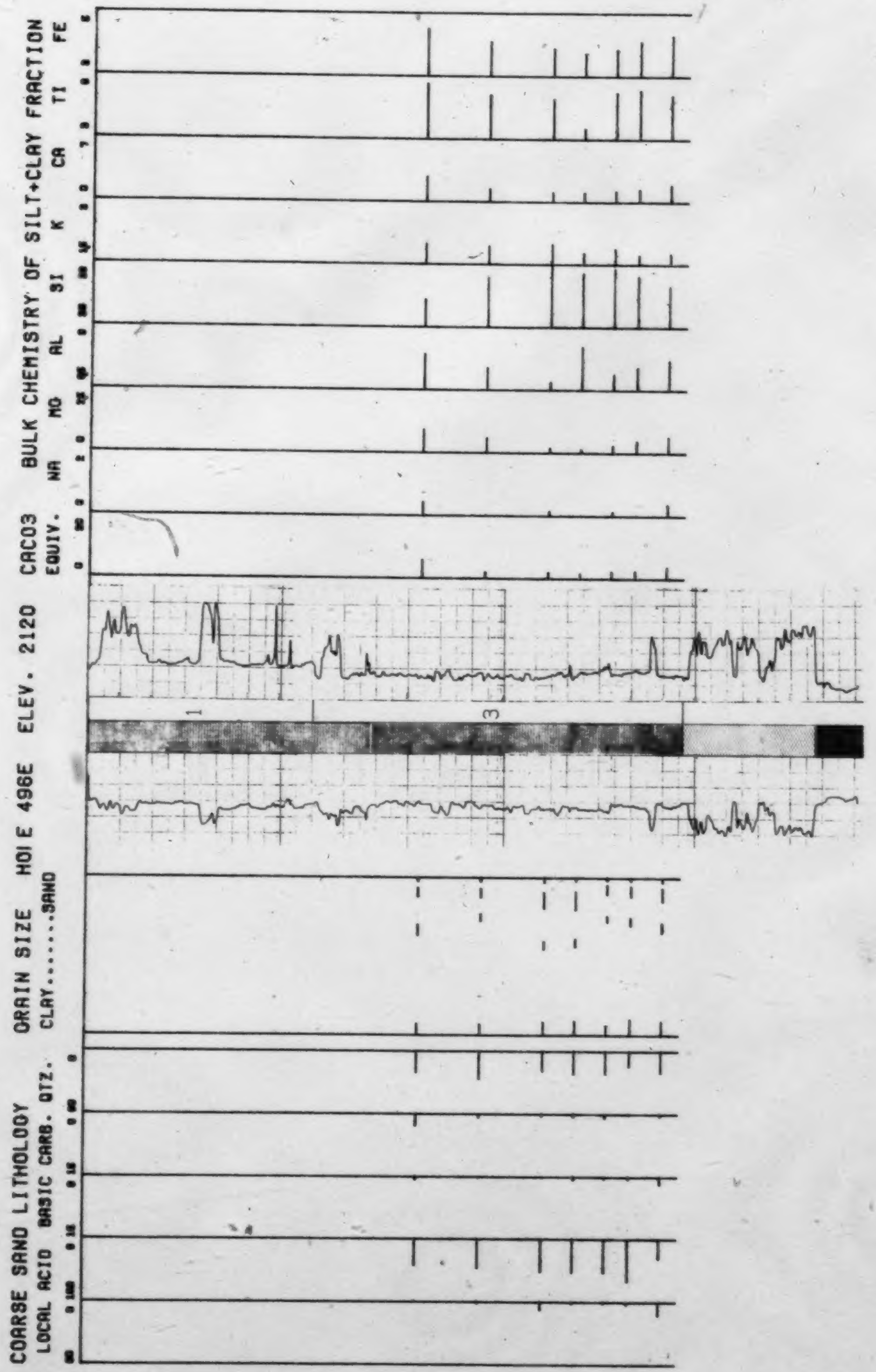
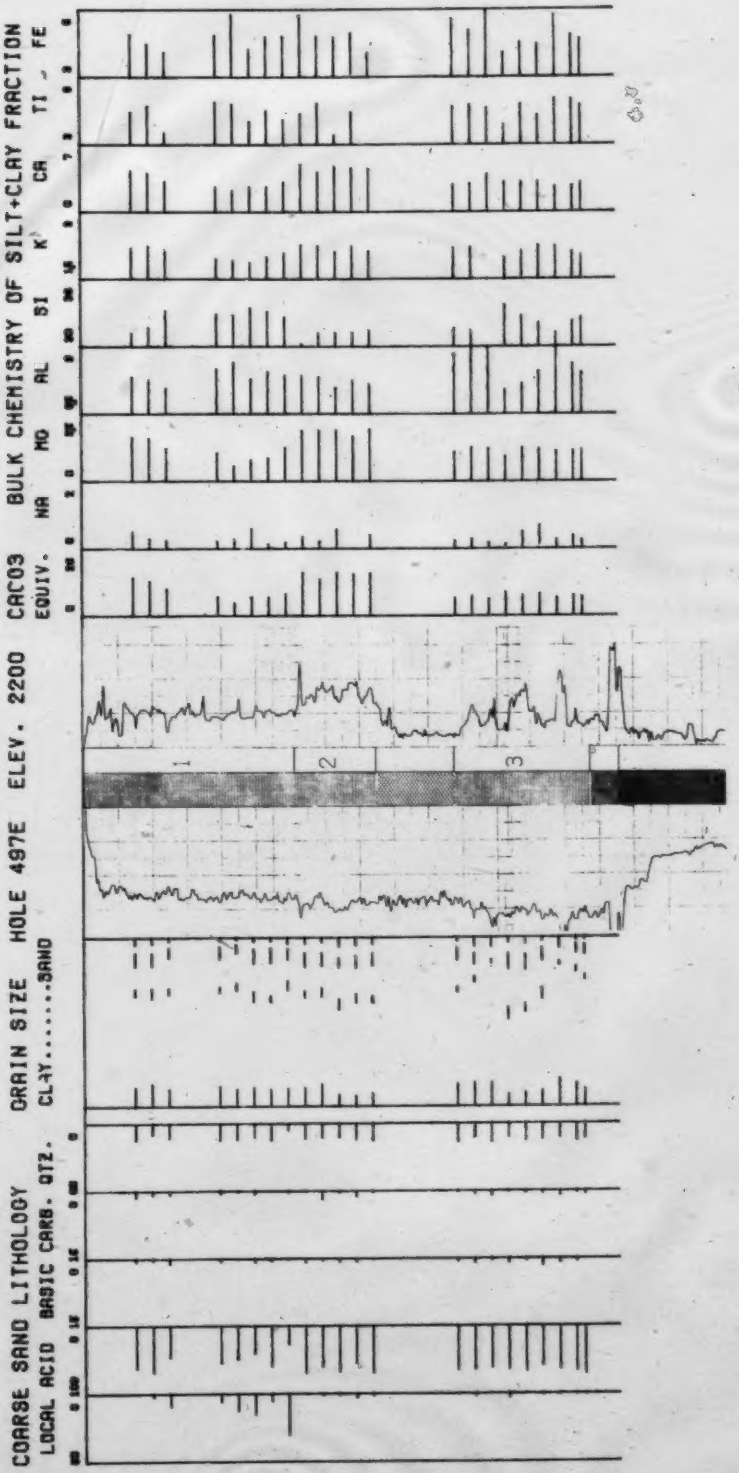
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY.......SAND
HOLE 473E
ELEV. 2025
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MG
AL
SI
K
CA
TI
FE
1


BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MG
AL
SI
K
CA
TI
FE
CACO3
EQUIV.
HOIE 496E ELEV. 2120
1
3
GRAIN SIZE
CLAY......SAND
COARSE SAND LITHOLOGY
LOCAL ACID BASIC CARB. QTZ.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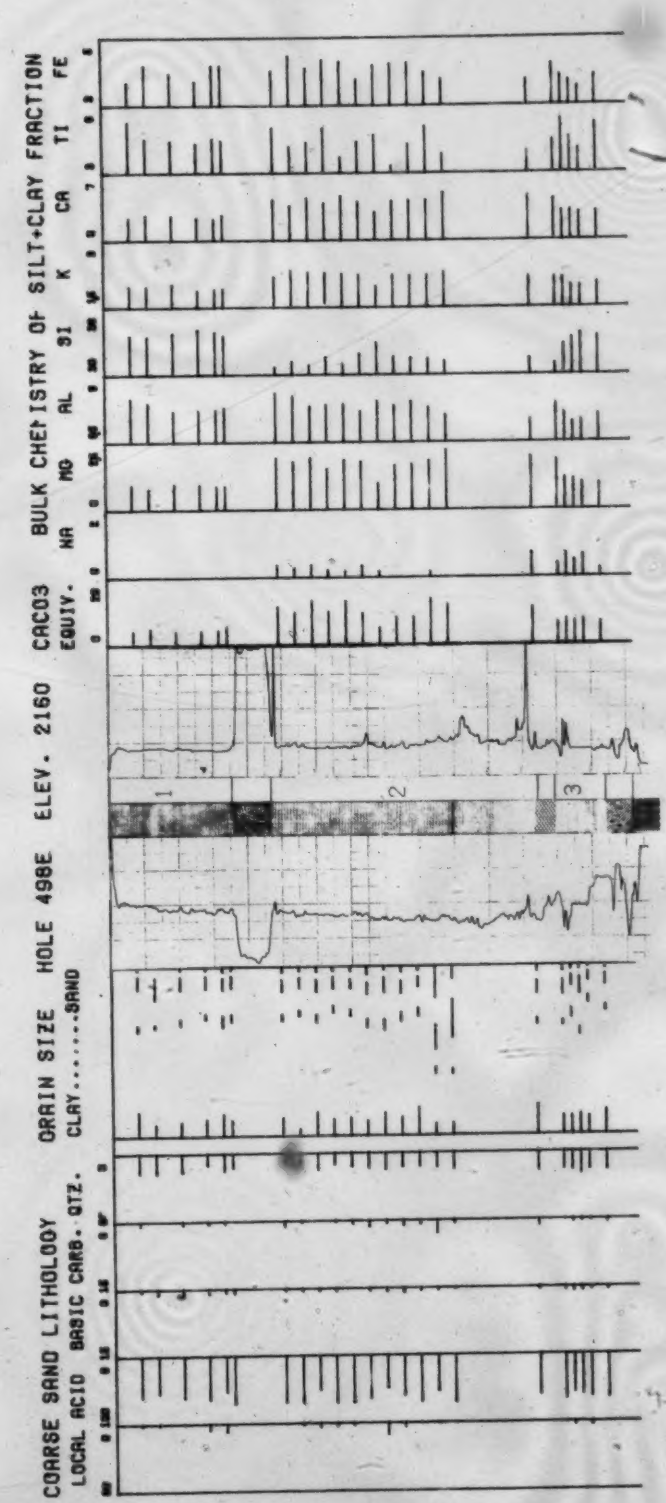
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY......SAND
HOLE 497E ELEV. 2200
1
2
3
CACO3 EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA MG AL SI K CA TI FE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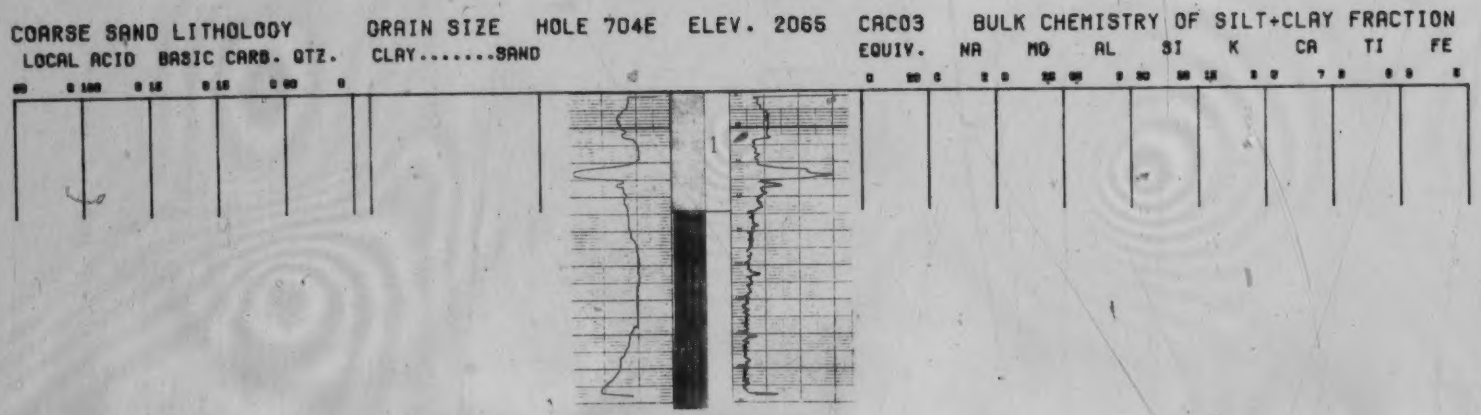
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY......SAND
HOLE 498E ELEV. 2160
1
2
3
CACO3 EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA MG AL SI K CA TI FE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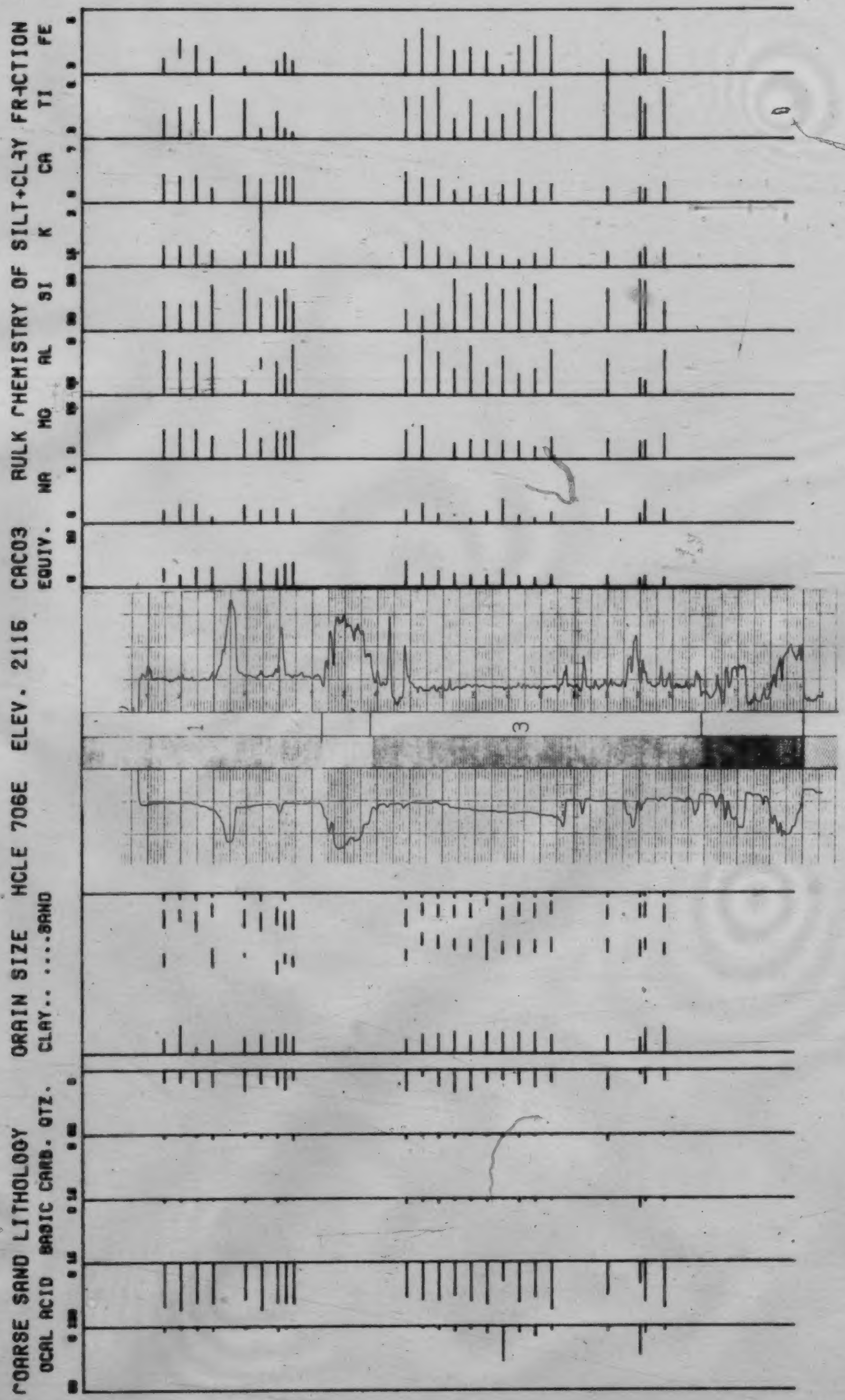
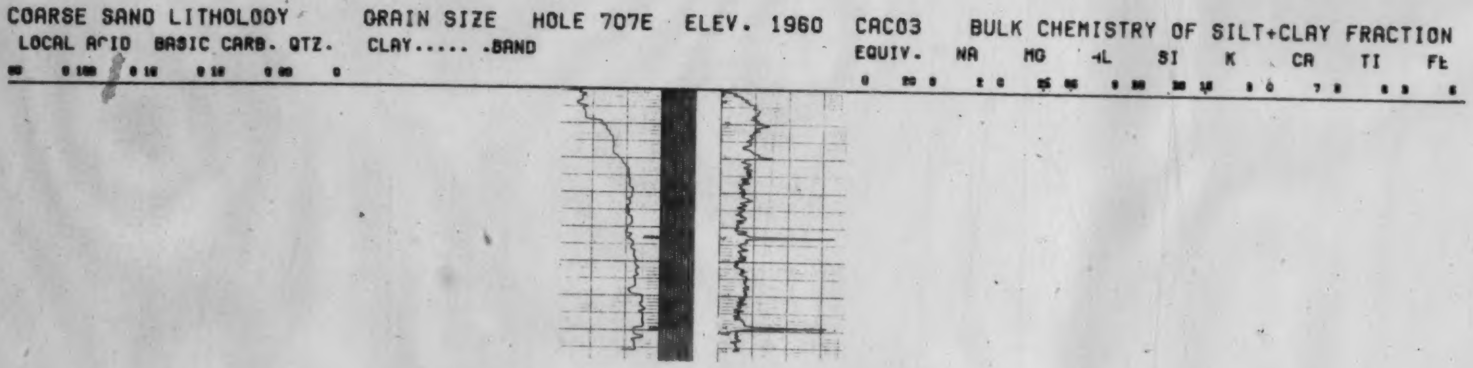
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY.......SAND
HOLE 704E
ELEV. 2065
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MG
AL
SI
K
CA
TI
FE
1


COARSE SAND LITHOLOGY
COAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY.. ....SAND
HOLE 706E
ELEV. 2116
1
3
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MG
AL
SI
K
CA
TI
FE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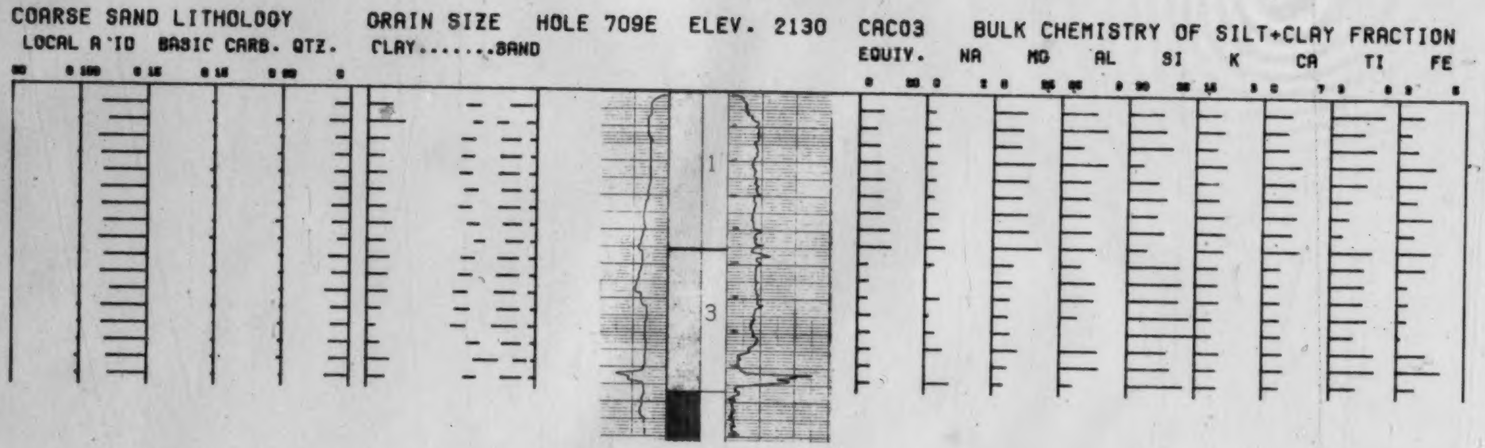
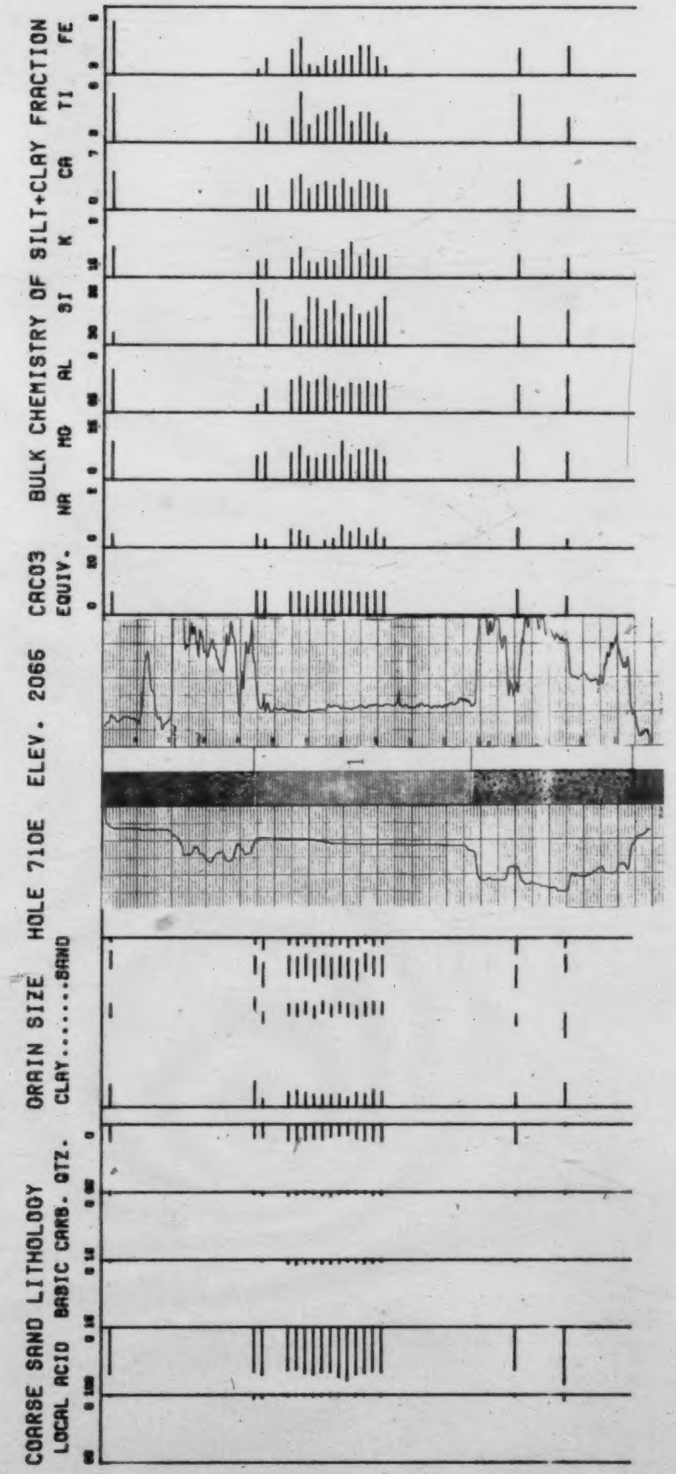
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY..... .SAND
HOLE 707E
ELEV. 1960
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MG
AL
SI
K
CA
TI
FE


COARSE SAND LITHOLOGY
LOCAL R'ID BASIC CARB. QTZ.
GRAIN SIZE
CLAY.......SAND
HOLE 709E ELEV. 2130
1
3
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MG
AL
SI
K
CA
TI
FE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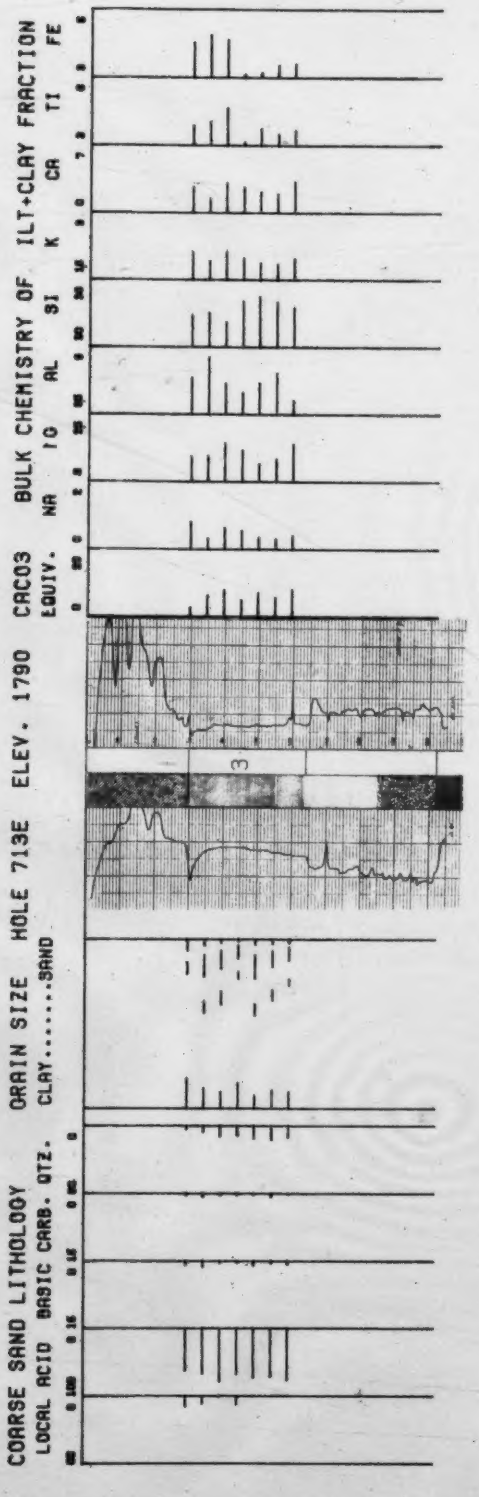
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY......SAND
HOLE 710E
ELEV. 2066
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MG
AL
SI
K
CA
TI
FE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LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY.......SAND
HOLE 713E ELEV. 1790
3
CACO3
EQUIV.
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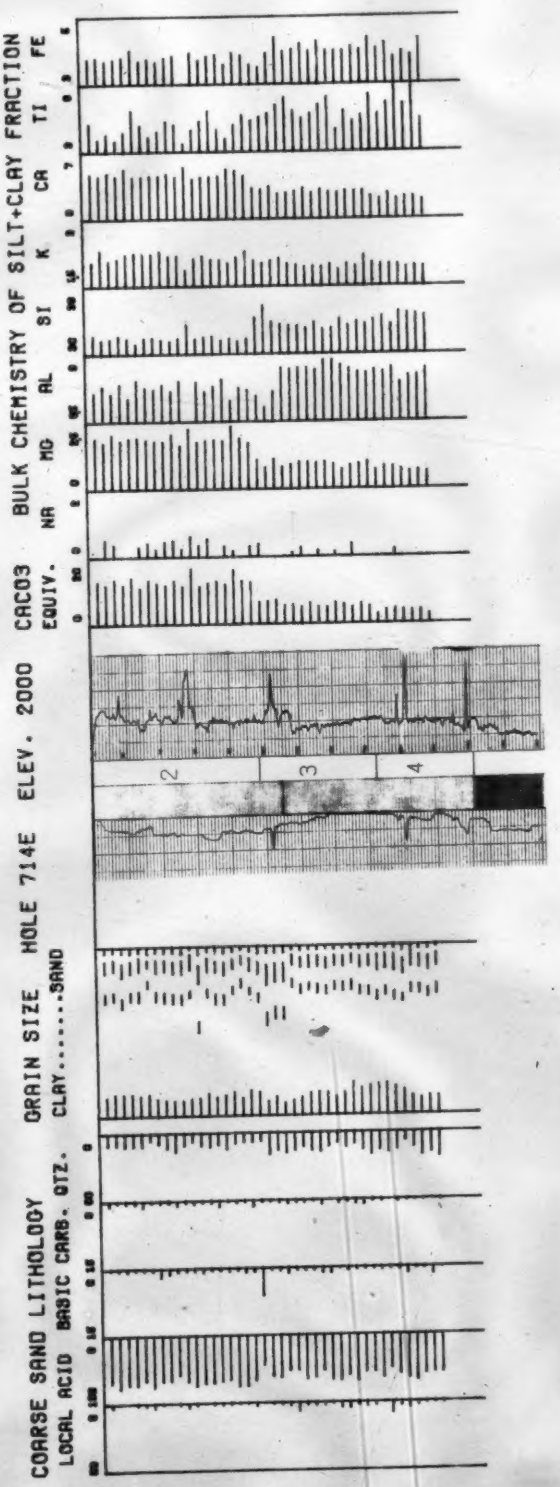
NA MG AL SI K CA TI FE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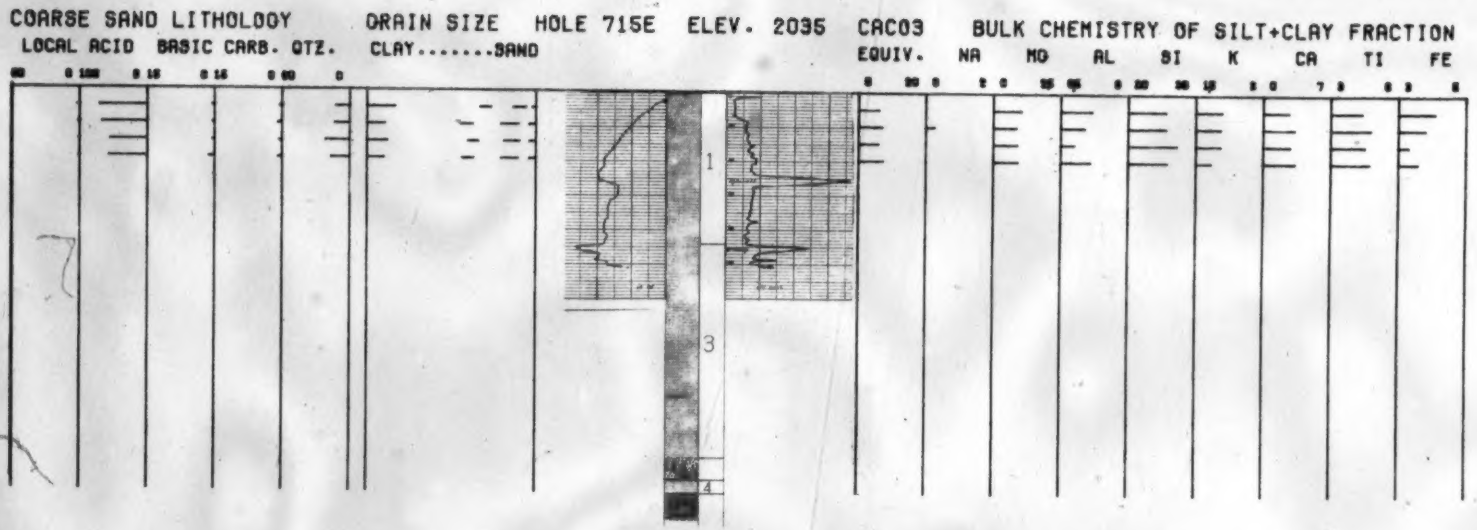
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY.......SAND
HOLE 714E ELEV. 2000
2
3
4
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA MG AL SI K CA TI FE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LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY.......SAND
HOLE 715E
ELEV. 2035
CACO3
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NA
MG
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SI
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CA
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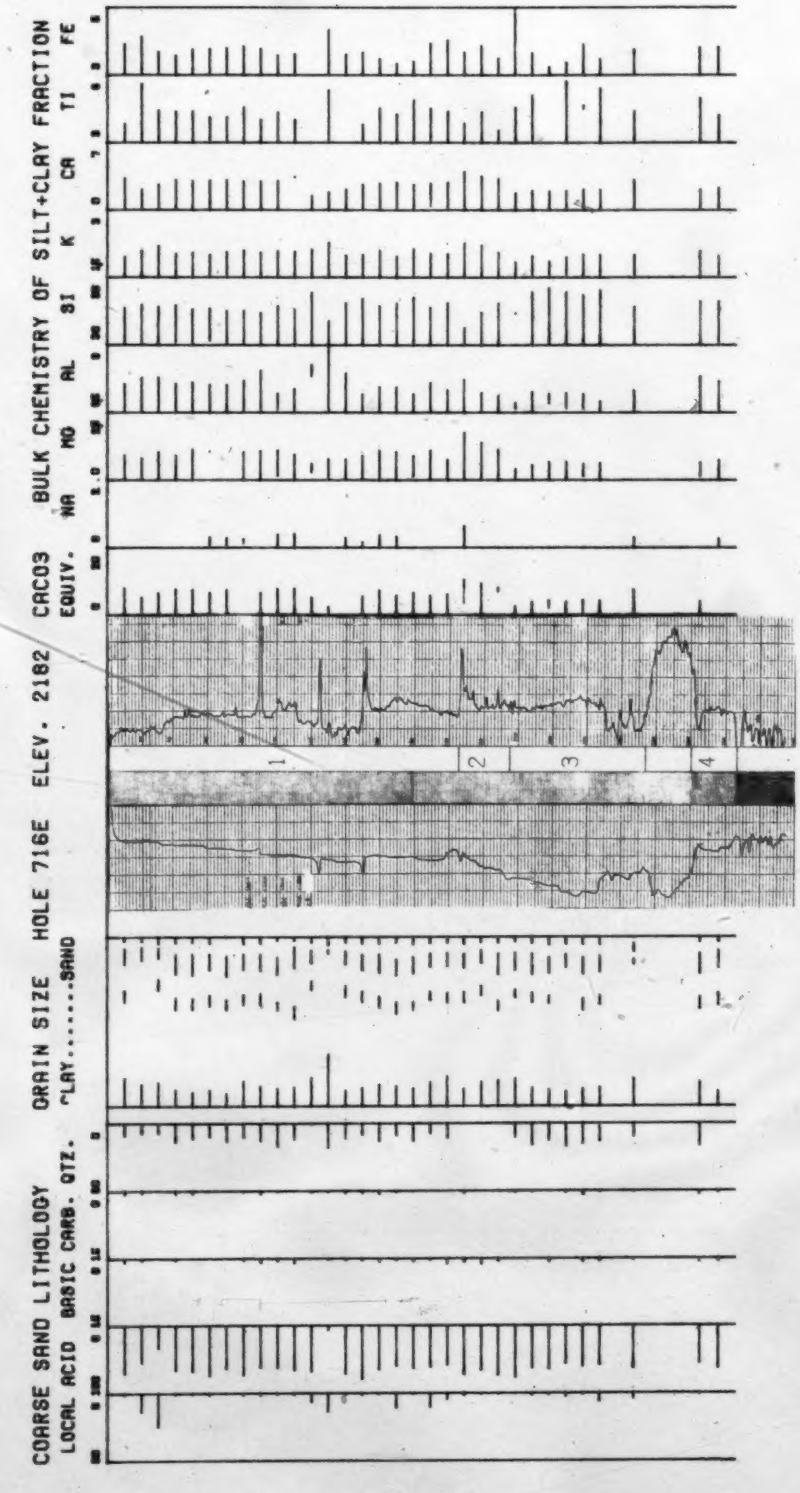
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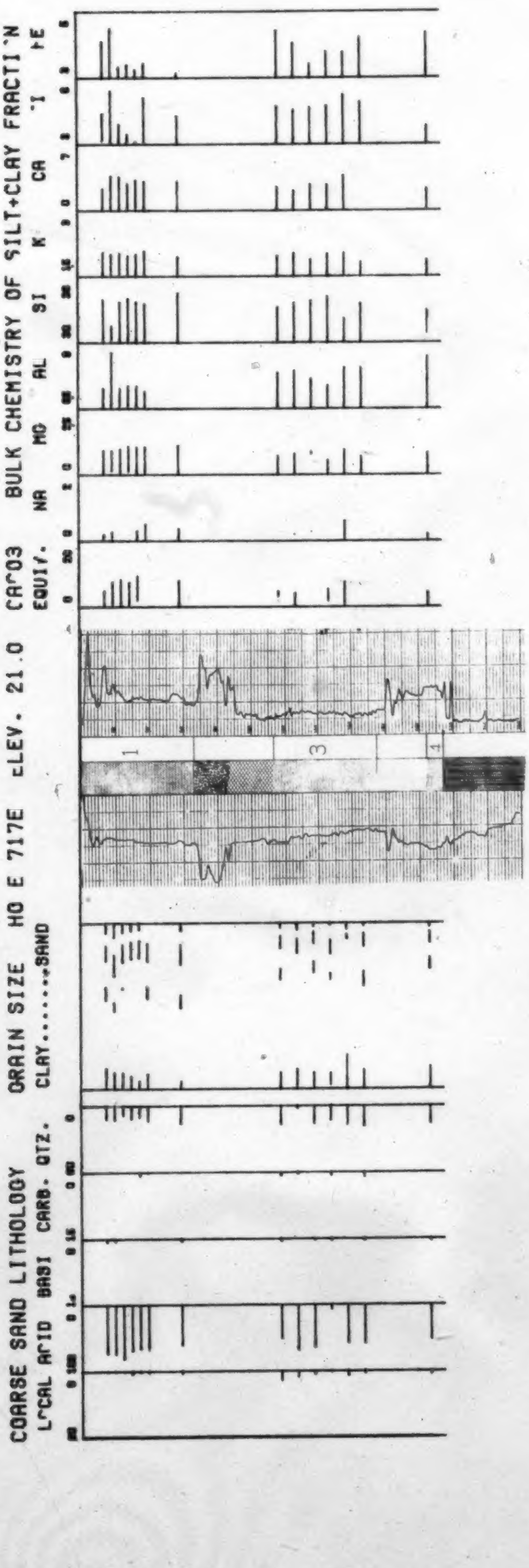
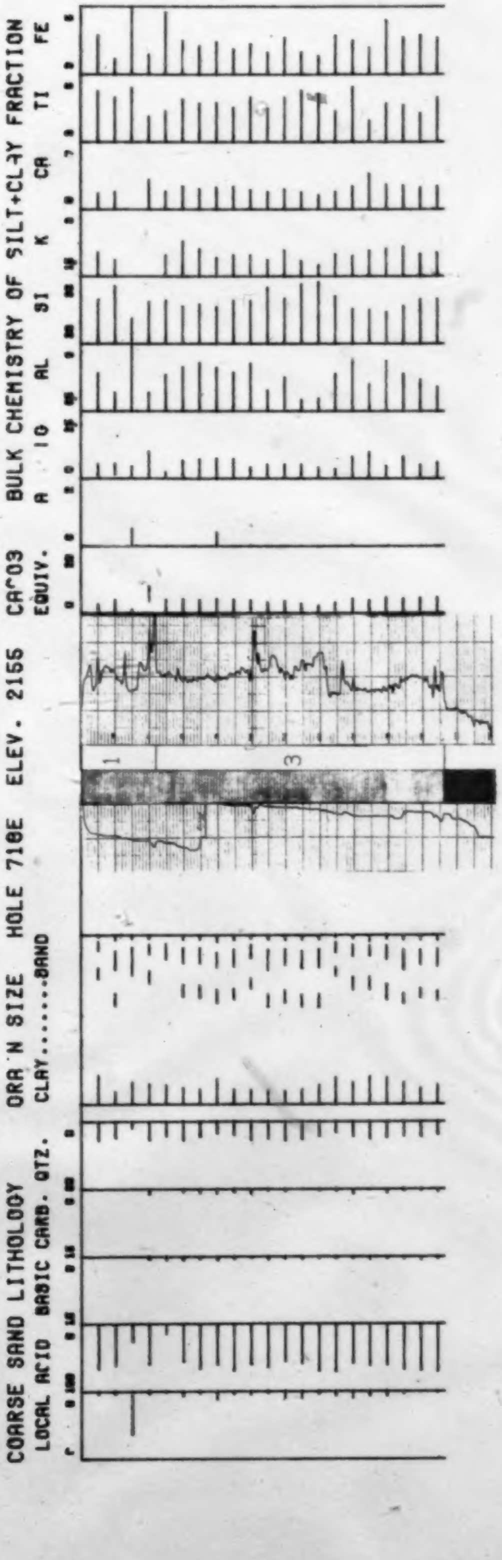
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY......SAND
HOLE 716E
ELEV. 2182
1
2
3
4
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MG
AL
SI
K
CA
TI
FE


COARSE SAND LITHOLOGY
L^CAL ACID BASI CARB. QTZ.
ORAIN SIZE
CLAY......SAND
HO E 717E
ELEV. 21.0
CA^03
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTI^N
NA
MG
AL
SI
K
CA
TI
FE
1
3
4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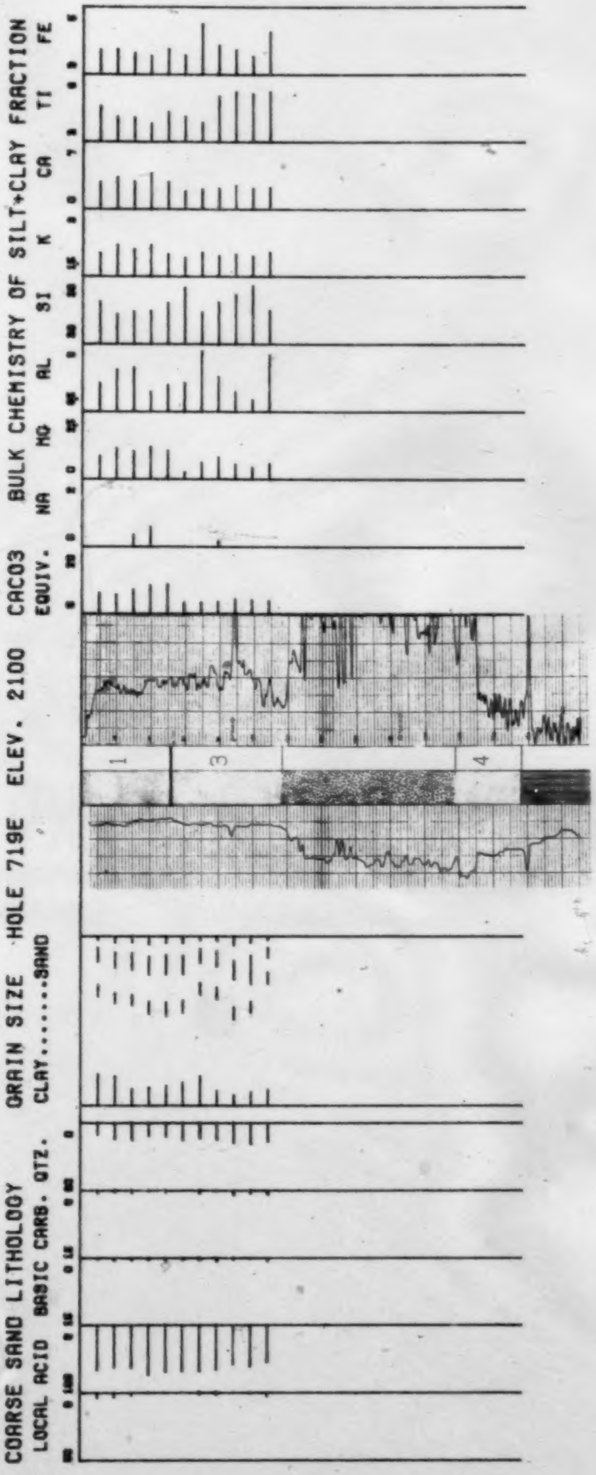
LOCAL ACID BASIC CARB. QTZ.
GRA N SIZE
CLAY......SAND
HOLE 718E
ELEV. 2155
CA^O3 EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
A IO AL SI K CA TI FE
1
3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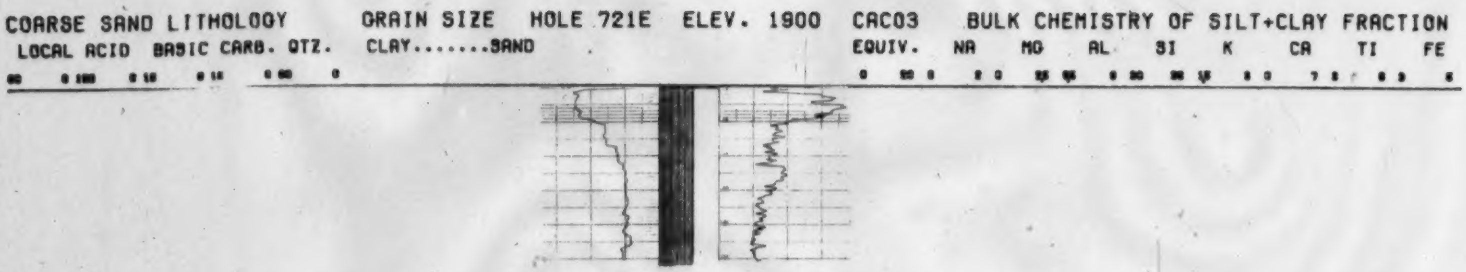
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY......SAND
HOLE 719E ELEV. 2100
1
3
4
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MG
AL
SI
K
CA
TI
FE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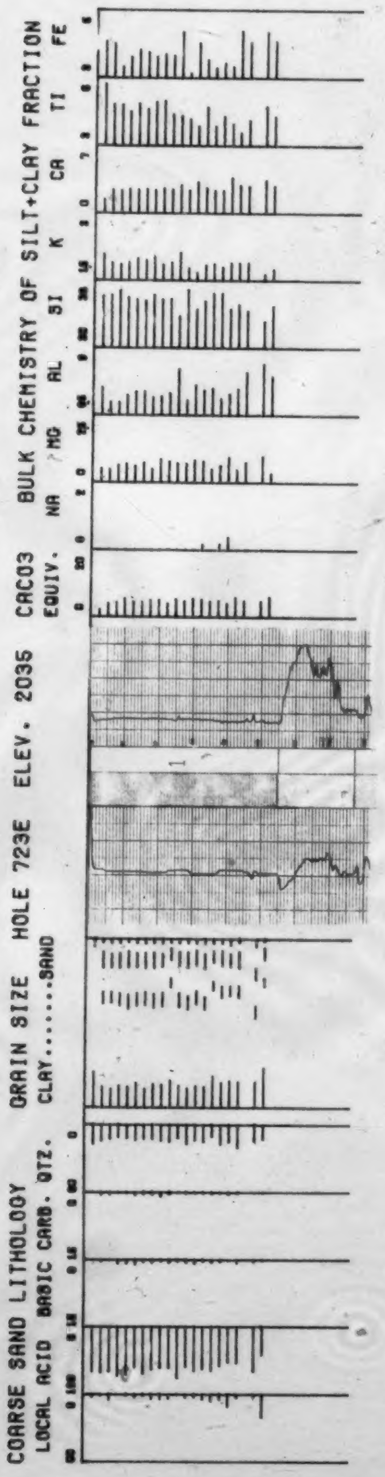
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY.......SAND
HOLE 721E
ELEV. 1900
CACO3 EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MG
AL
SI
K
CA
TI
FE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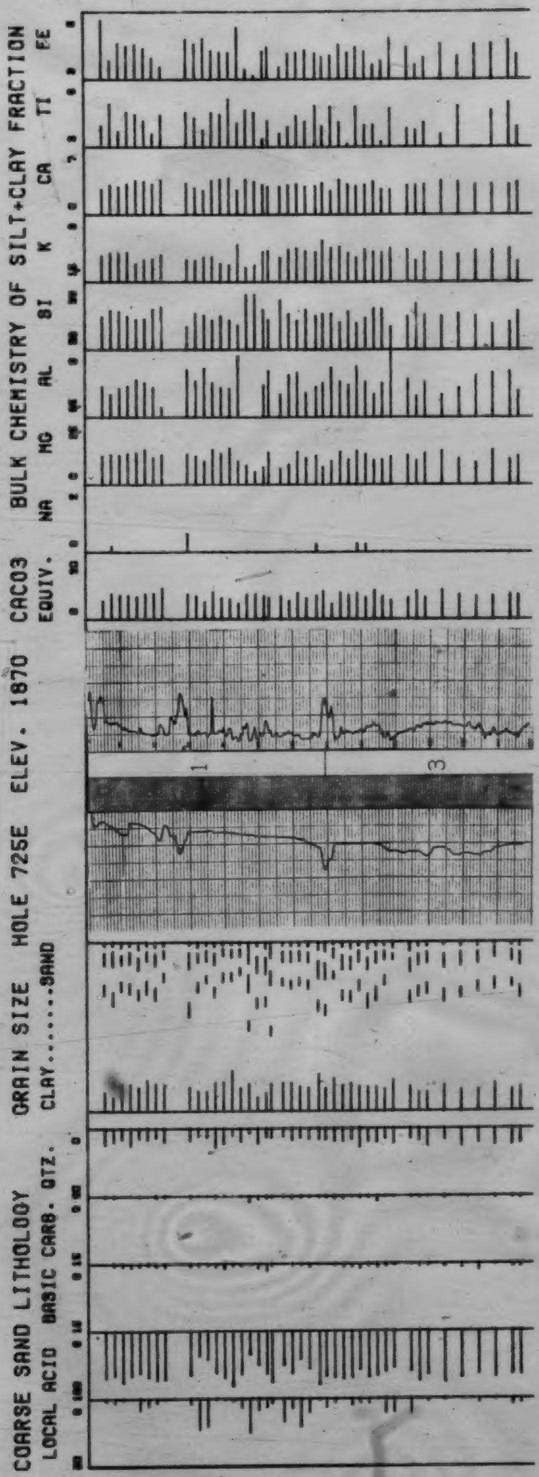
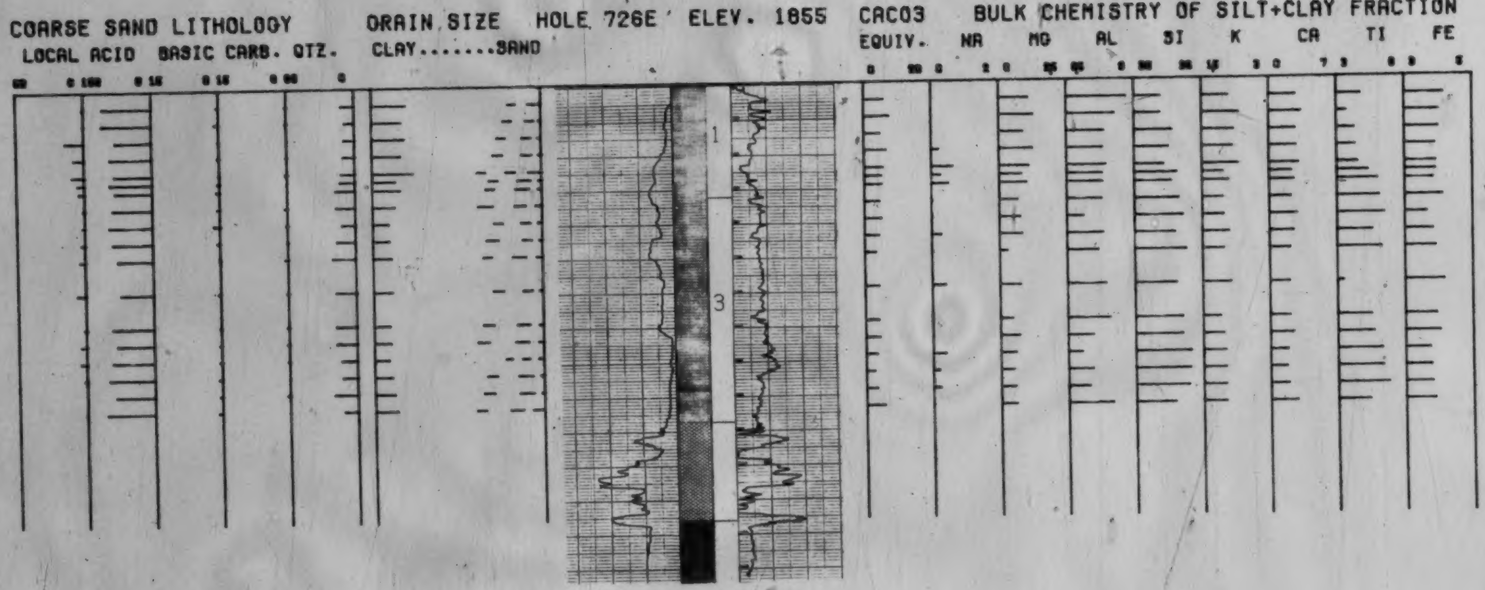
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY......SAND
HOLE 723E
ELEV. 2035
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MG
AL
SI
K
CA
TI
FE


COARSE SAND LITHOLOGY
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY......SAND
HOLE 725E ELEV. 1870
1
3
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA MG AL SI K CA TI FE


COARSE SAND LITHOLOGY
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY.......SAND
HOLE 726E' ELEV. 1855
1
3
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MG
AL
SI
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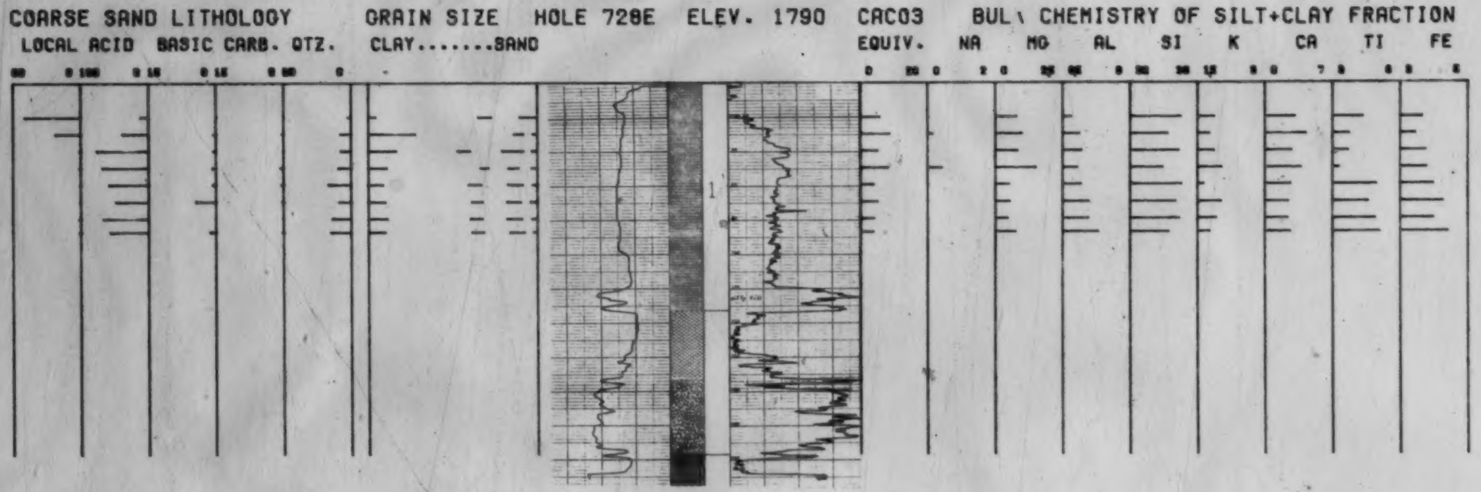
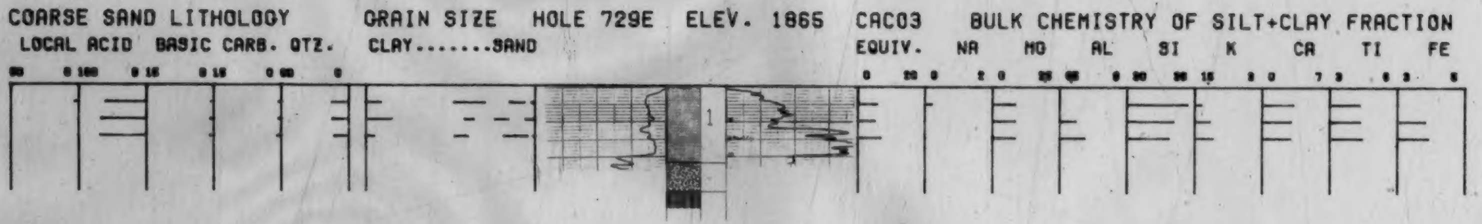
CA
TI
FE


COARSE SAND LITHOLOGY
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY.......SAND
HOLE 728E ELEV. 1790
CACO3
EQUIV.
BUL\ CHEMISTRY OF SILT+CLAY FRACTION
NA MG AL SI K CA TI FE


COARSE SAND LITHOLOGY
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY.......SAND
HOLE 729E
ELEV. 1865
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MG
AL
SI
K
CA
TI
FE
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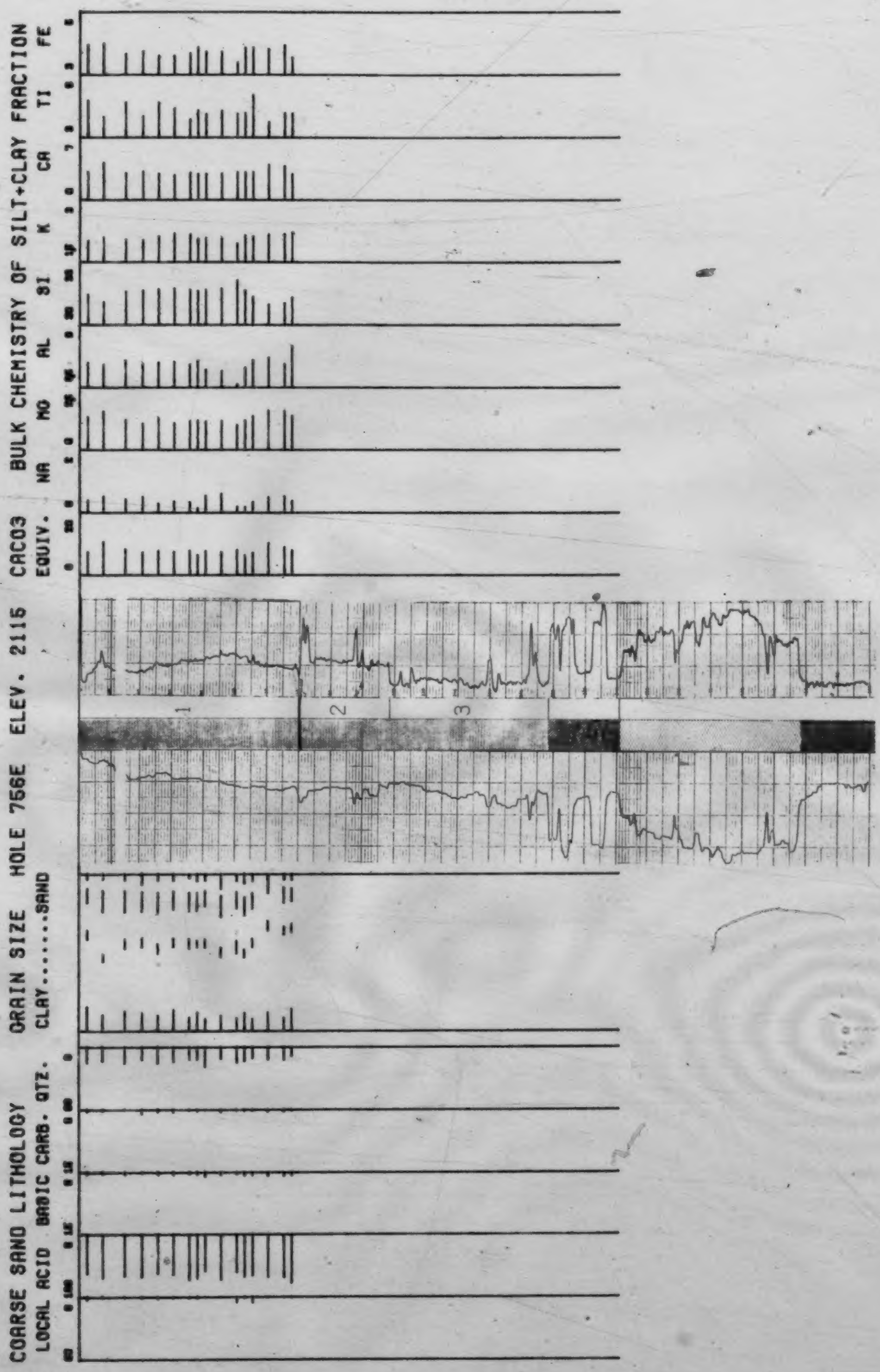
COARSE SAND LITHOLOGY
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY......SAND
HOLE 756E
ELEV. 2115
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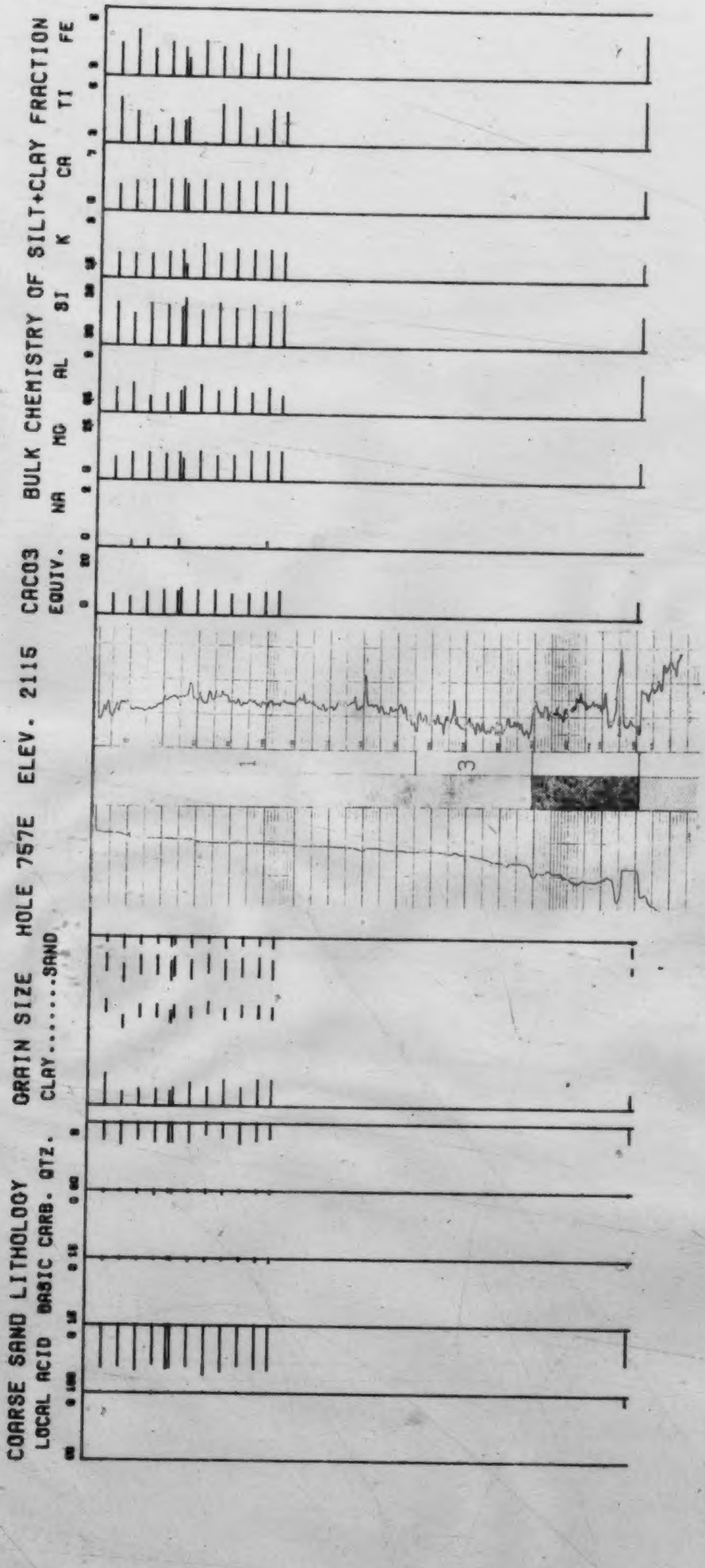
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MG
AL
SI
K
CA
TI
FE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LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY......SAND
HOLE 757E
ELEV. 2115
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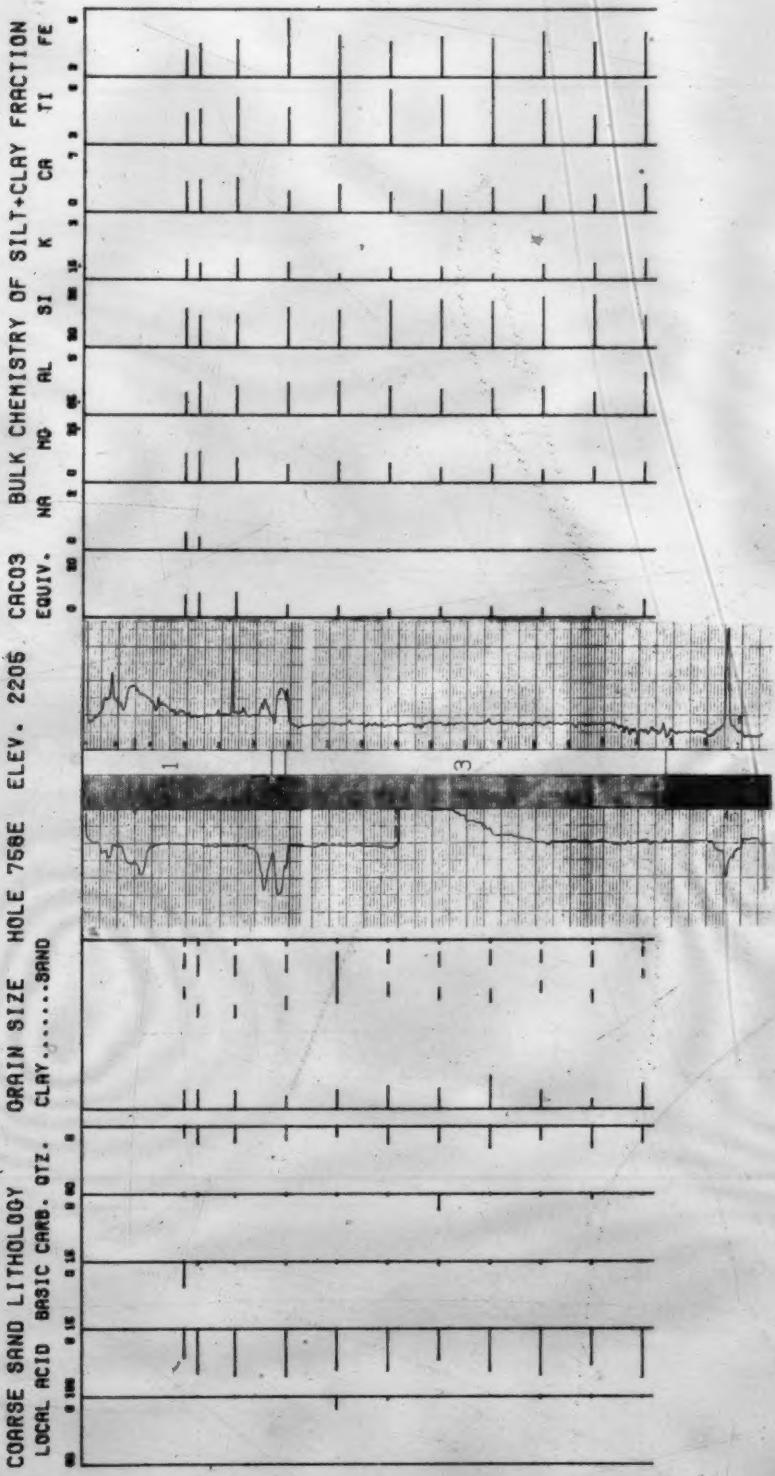
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MG
AL
SI
K
CA
TI
FE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GRAIN SIZE
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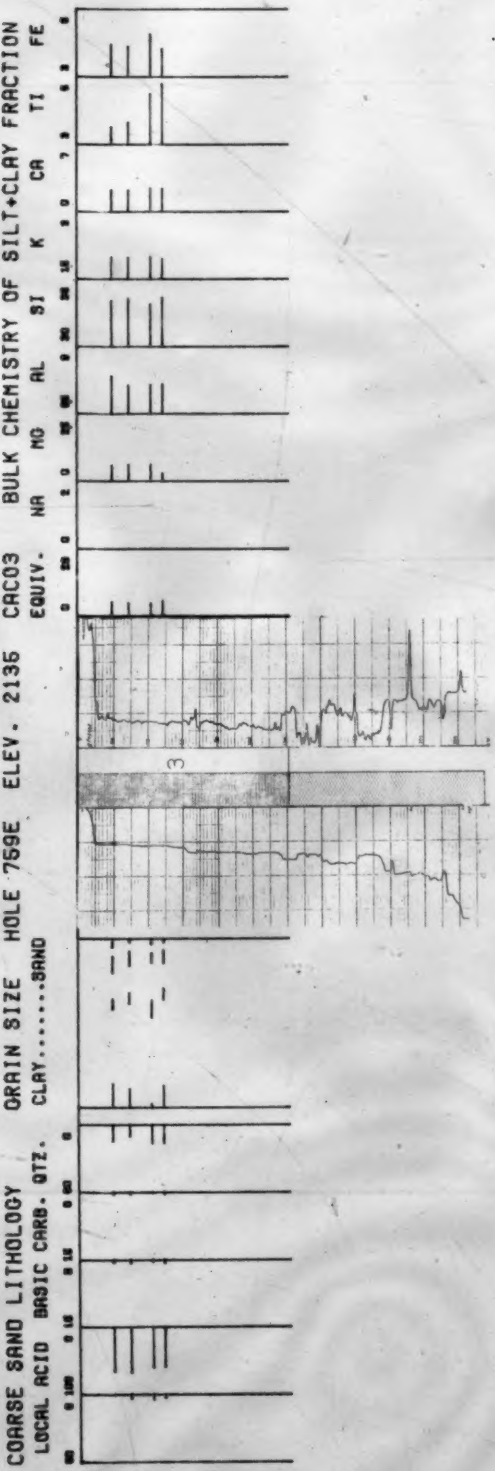
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA MG AL SI K CA TI FE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LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY......SAND
HOLE 759E
ELEV. 2136
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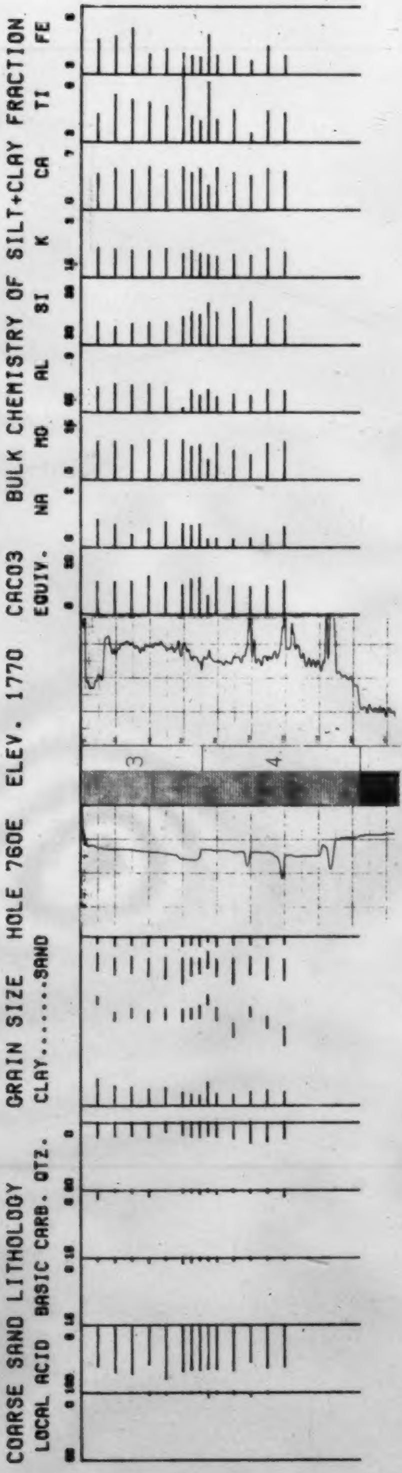
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA MG AL SI K CA TI FE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LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY.......SAND
HOLE 760E ELEV. 1770
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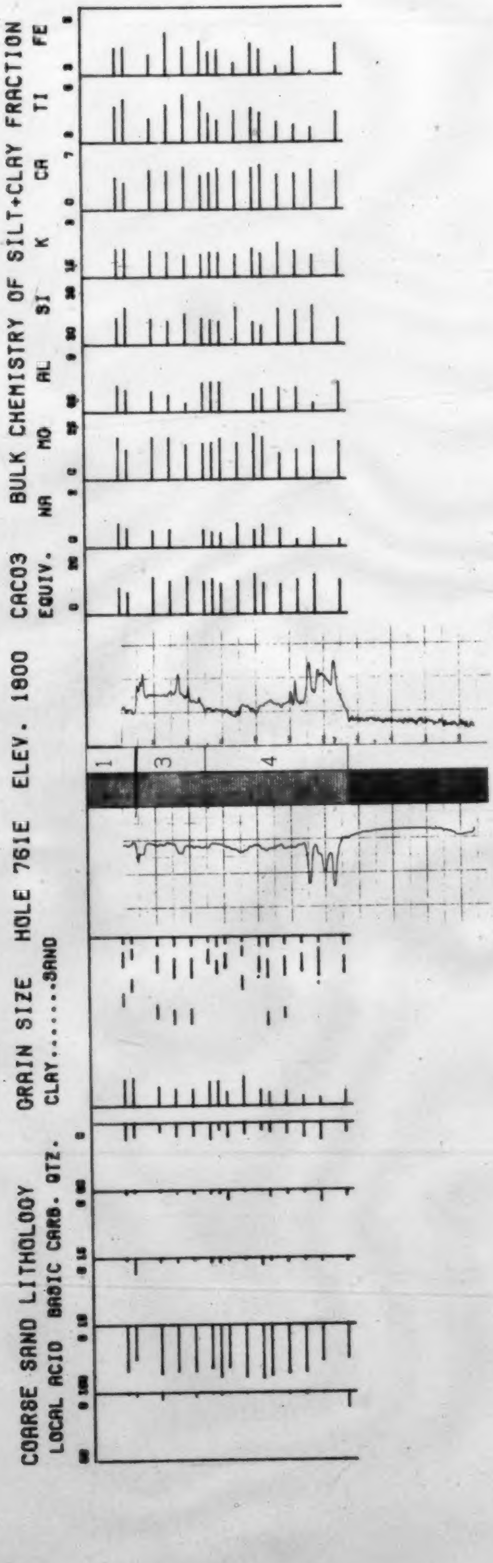
CACO3 EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA MG AL SI K CA TI FE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LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY......SAND
HOLE 761E ELEV. 1800
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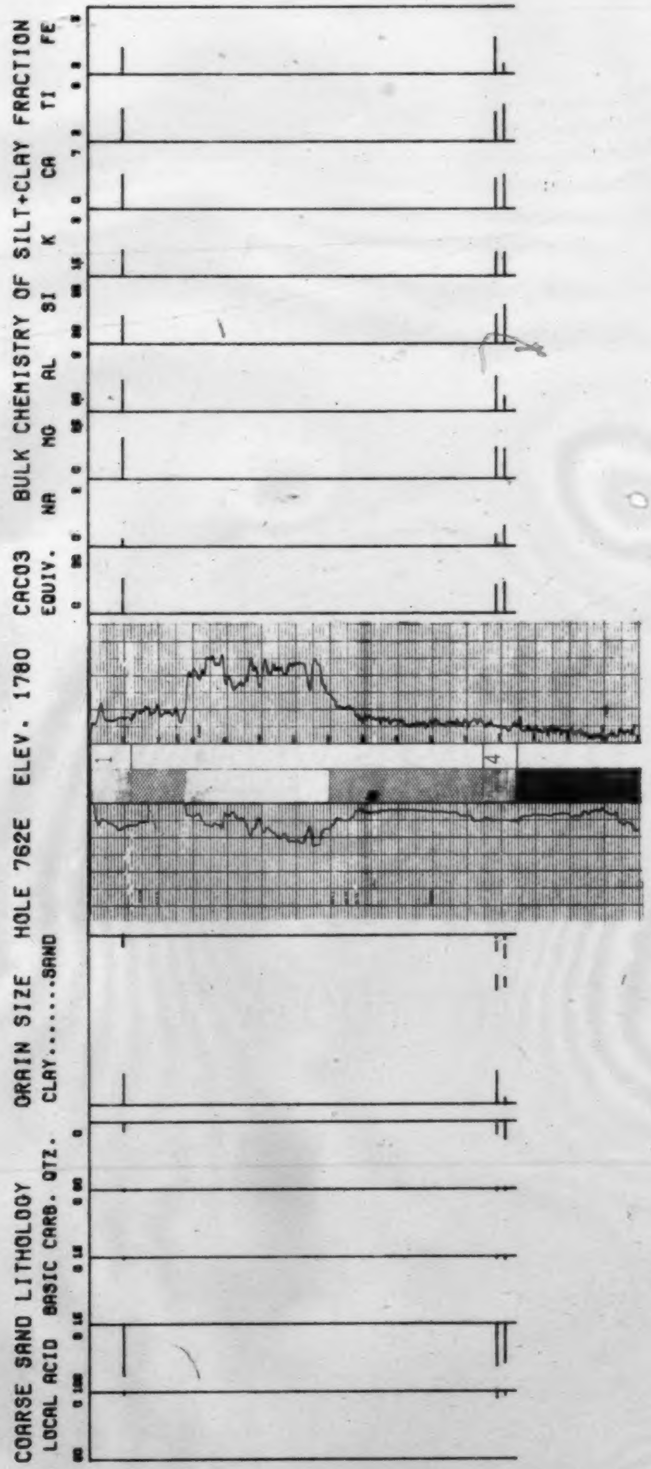
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA MG AL SI K CA TI FE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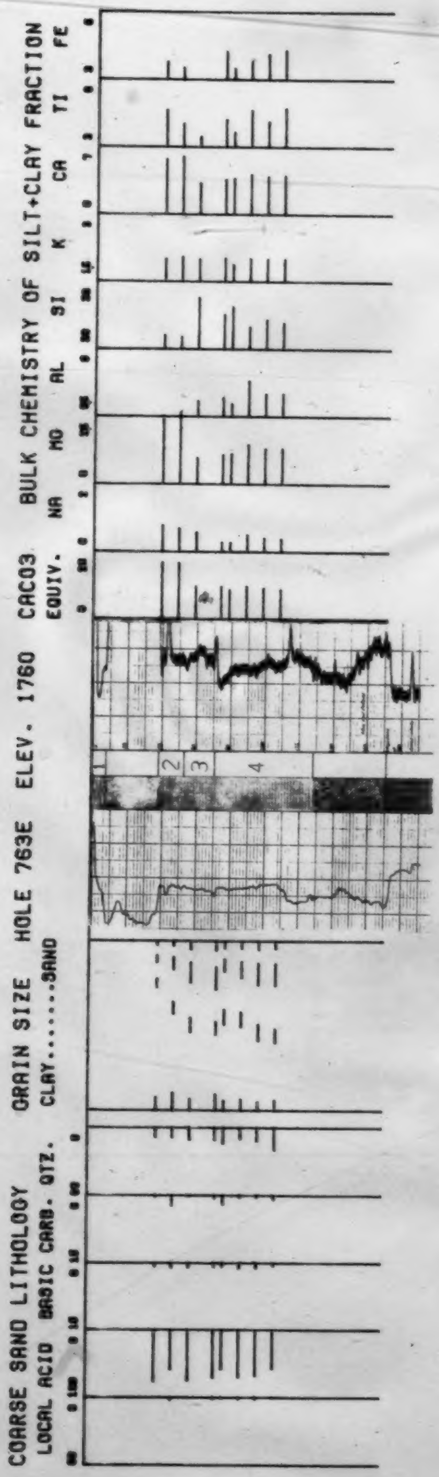
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY......SAND
HOLE 762E
ELEV. 1780
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MG
AL
SI
K
CA
TI
FE
4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LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY......SAND
HOLE 763E ELEV. 1760
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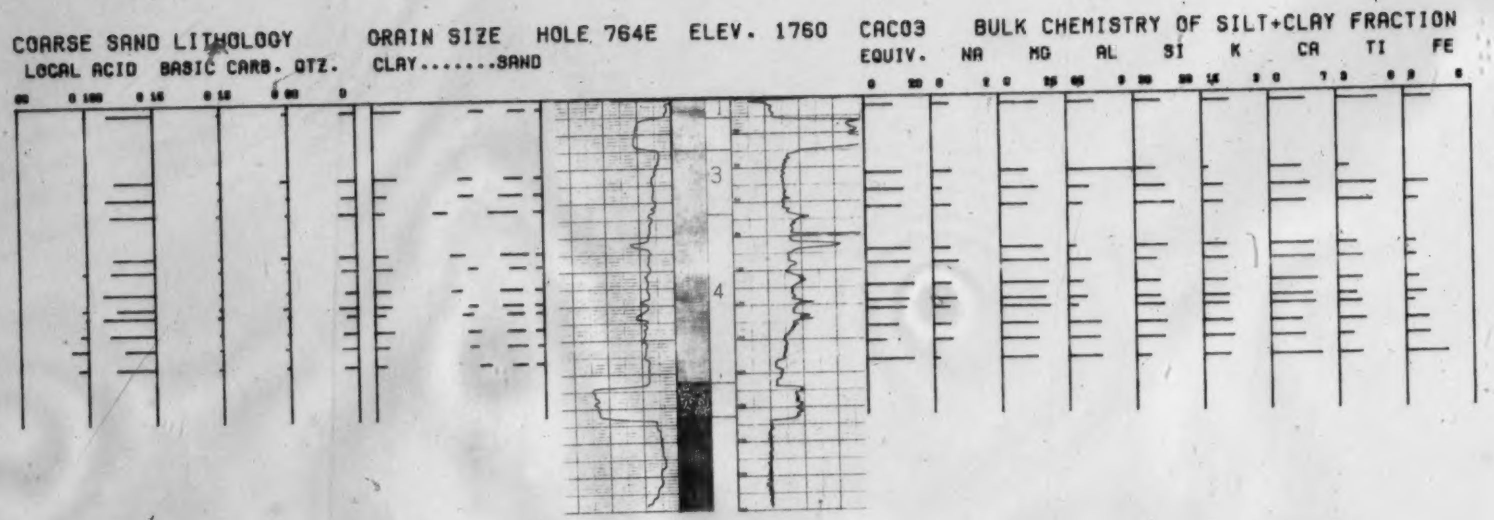
CACO3 EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA MG AL SI K CA TI FE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LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY.......SAND
HOLE 764E
ELEV. 1760
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
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MG
AL
SI
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CA
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3
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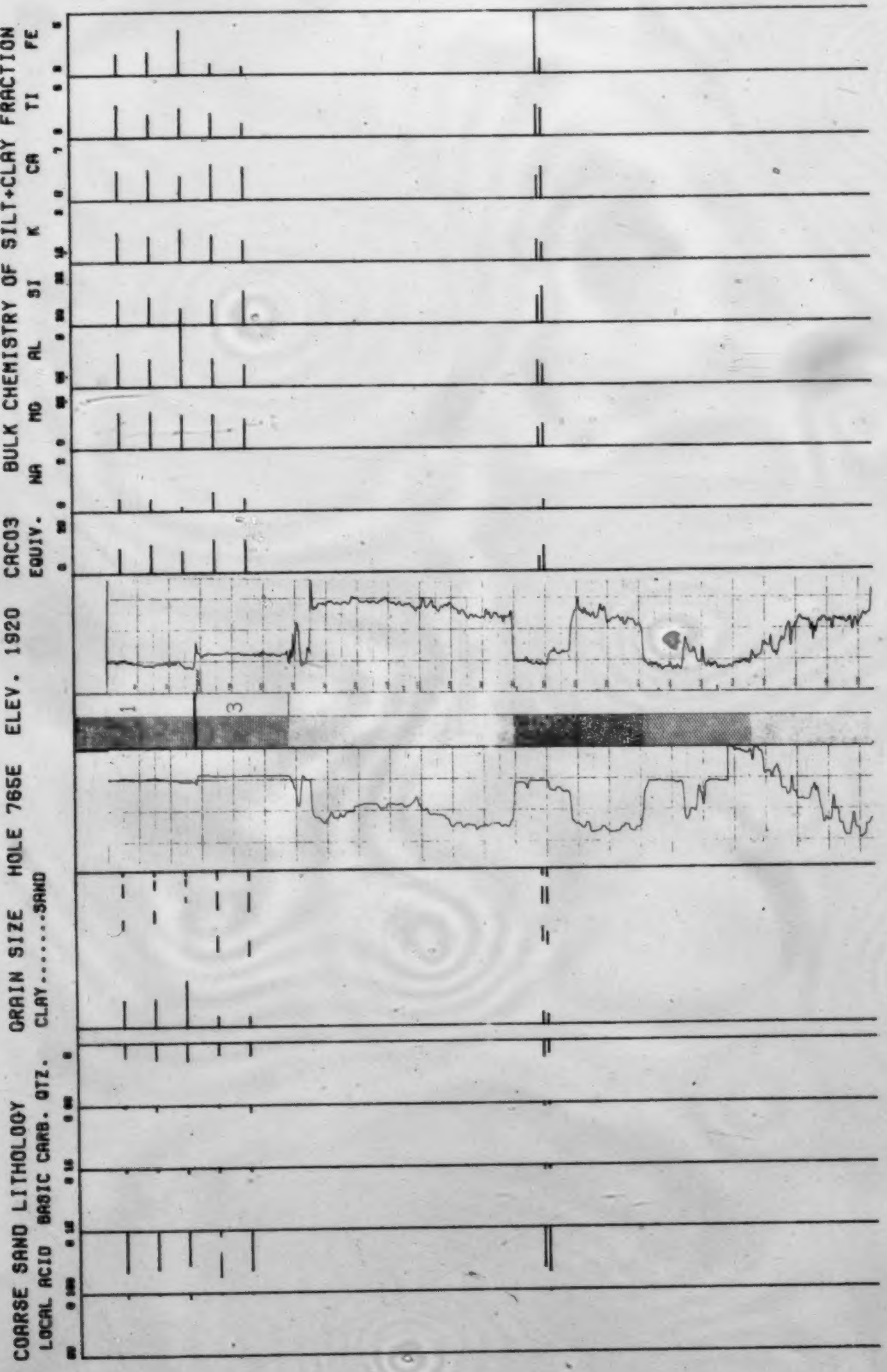
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MG
AL
SI
K
CA
TI
FE
CACO3
EQUIV.
ELEV. 1920
HOLE 765E
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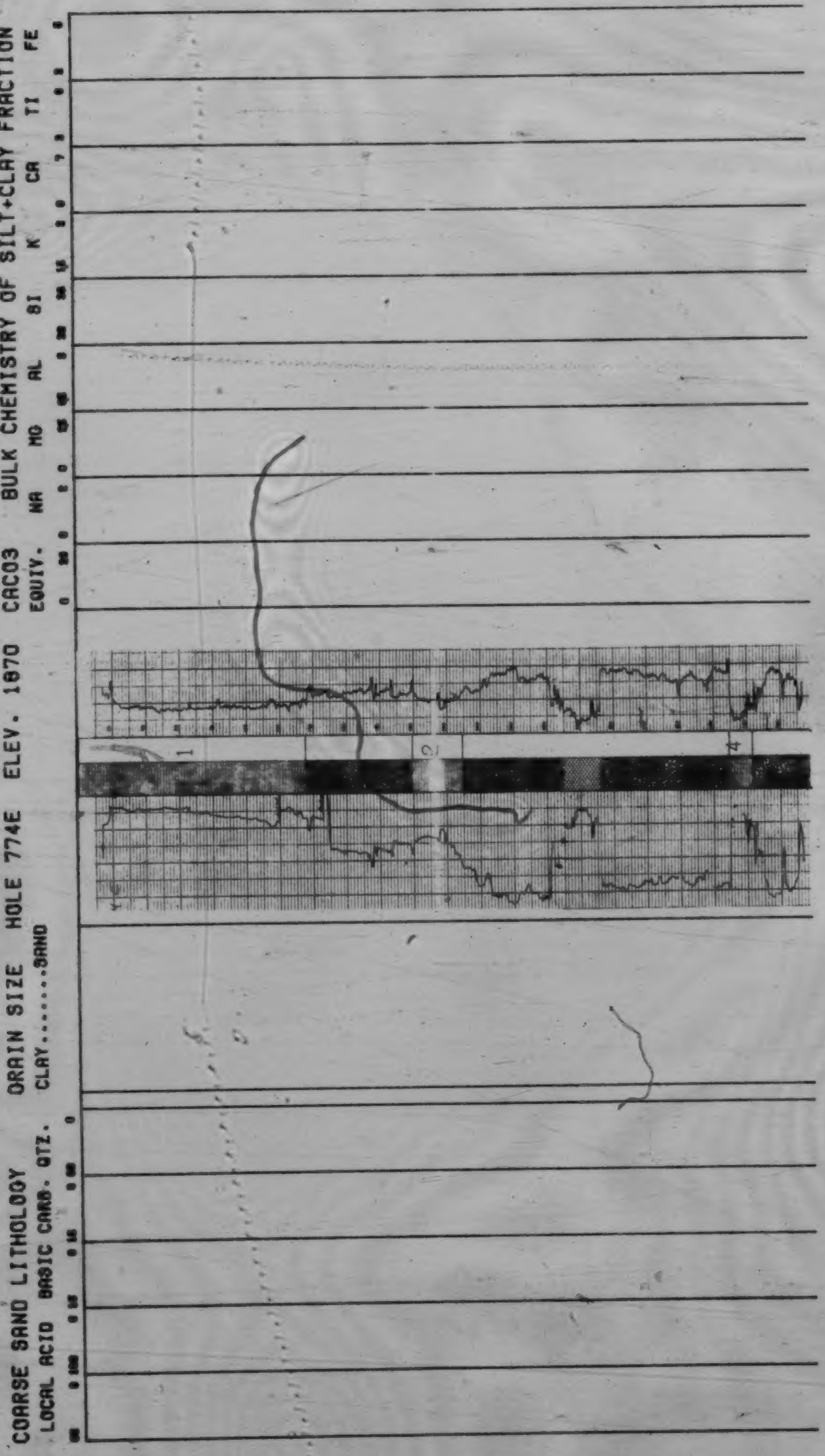
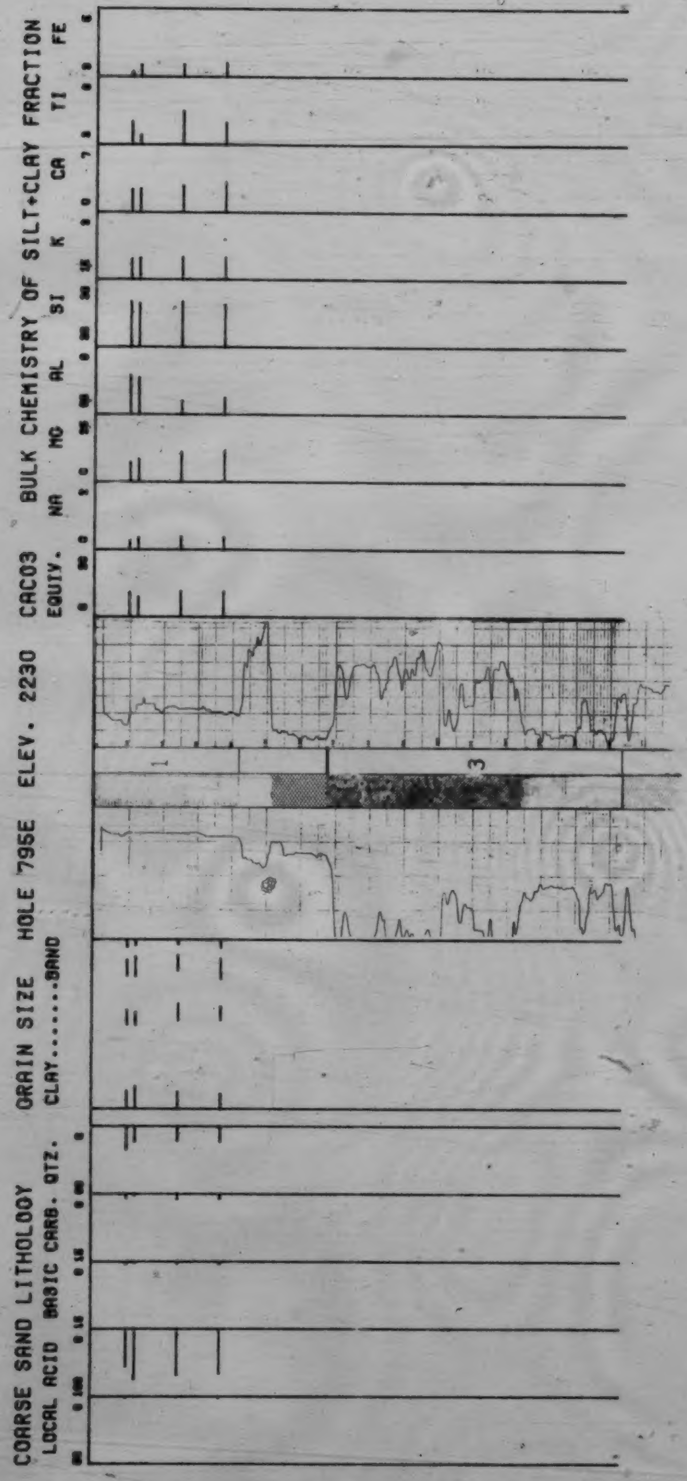
3
GRAIN SIZE
CLAY......SAND
COARSE SAND LITHOLOGY
LOCAL
ACID
BASIC
CARB.
QTZ.


COARSE SAND LITHOLOGY
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY......SAND
HOLE 774E
ELEV. 1870
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA MG AL SI K CA TI FE
1
2
4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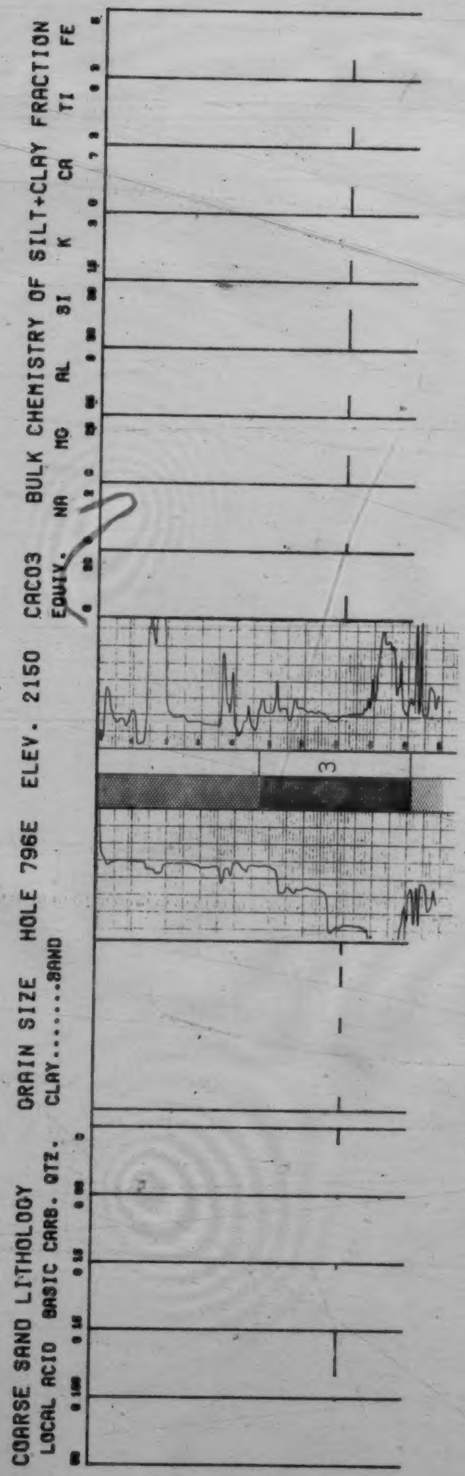
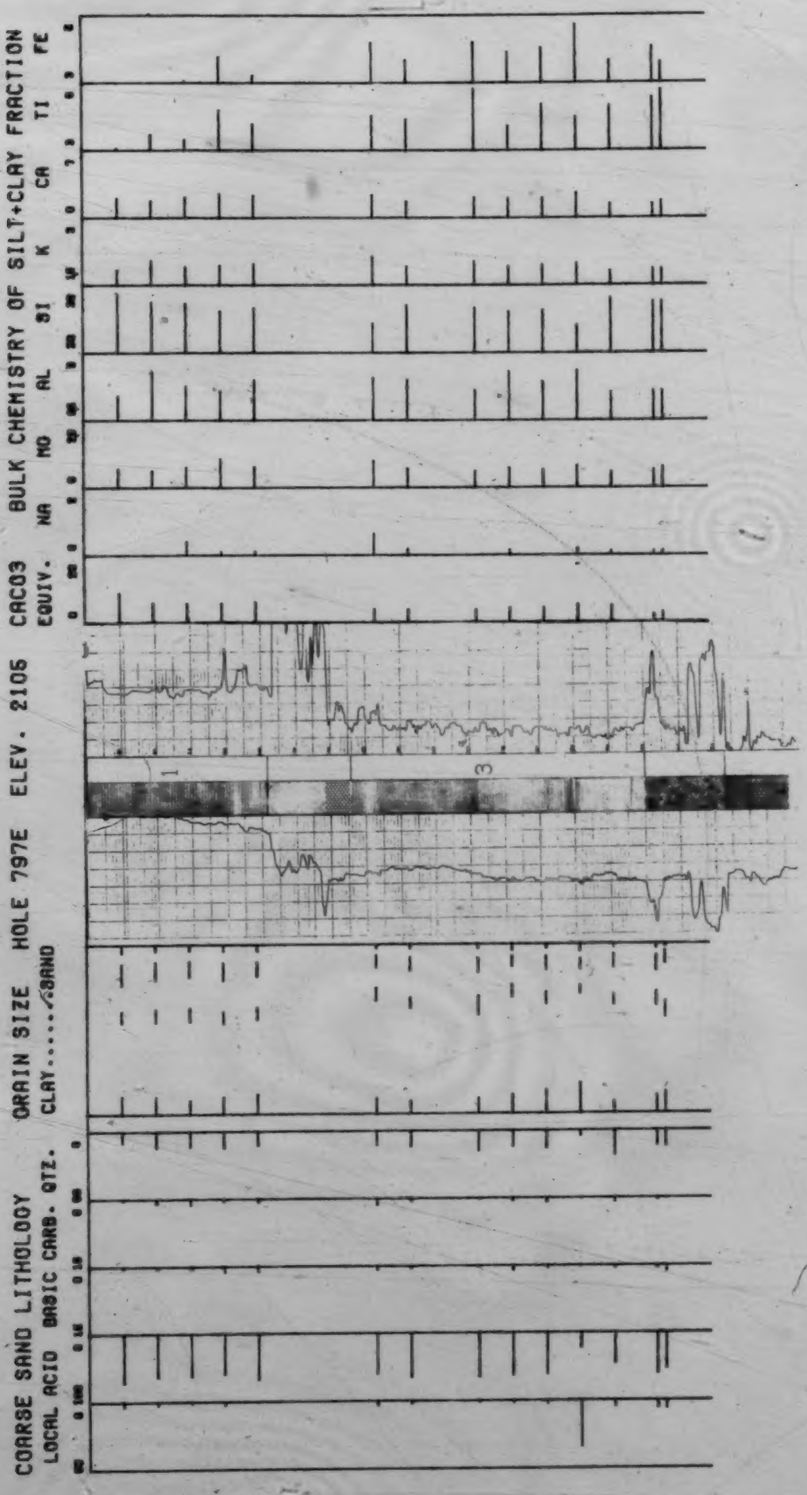
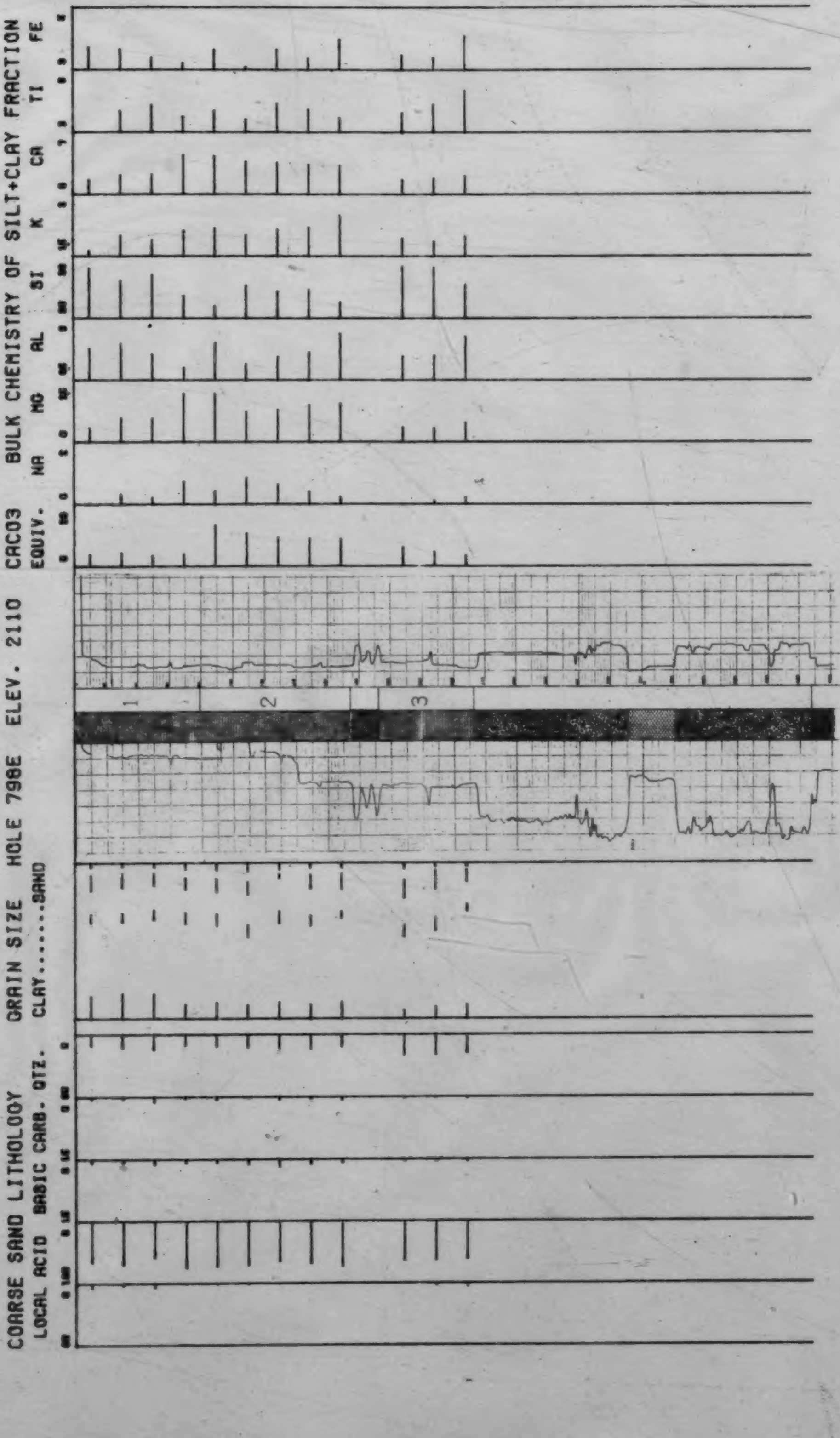
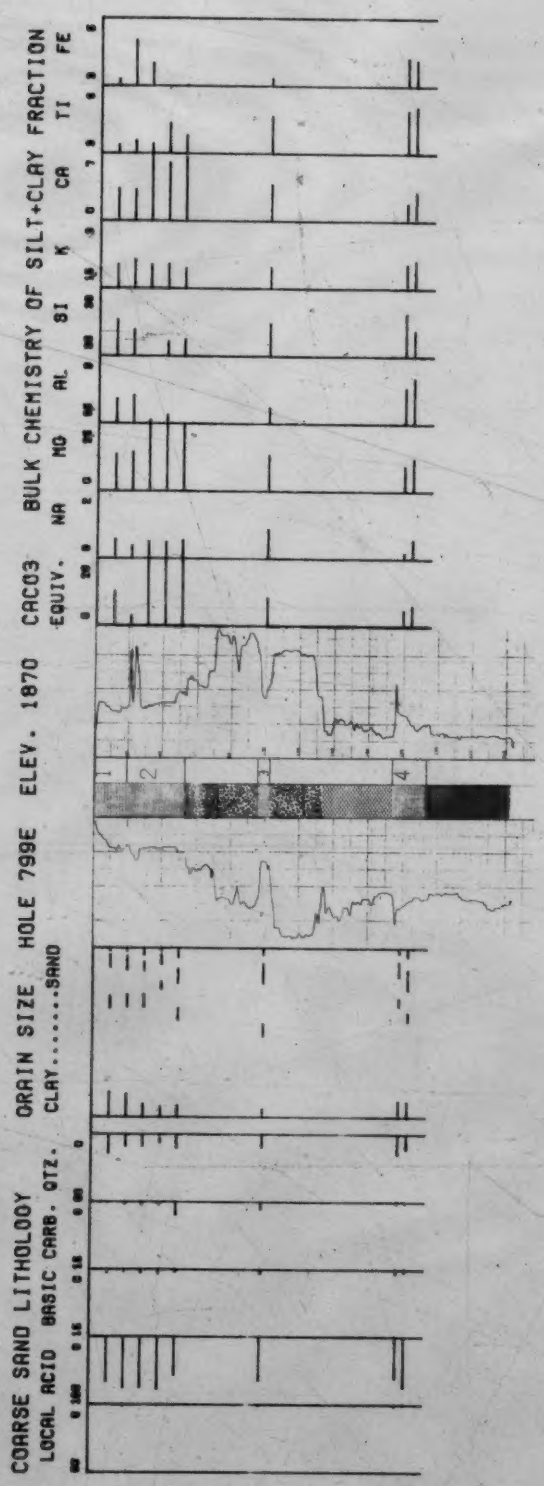
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY......SAND
HOLE 795E
ELEV. 2230
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MG
AL
SI
K
CA
TI
FE
1
3


COARSE SAND LITHOLOGY
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE HOLE 796E ELEV. 2150
CLAY......SAND
3
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA MG AL SI K CA TI FE


BULK CHEMISTRY OF SILT+CLAY FRACTION
FE
TI
CA
K
SI
AL
MG
NA
CACO3 EQUIV.
HOLE 797E ELEV. 2105
1
3
GRAIN SIZE
CLAY.....SAND
COARSE SAND LITHOLOGY
LOCAL ACID BASIC CARB. QTZ.


BULK CHEMISTRY OF SILT+CLAY FRACTION
CACO3 EQUIV.
NA
MG
AL
SI
K
CA
TI
FE
HOLE 798E ELEV. 2110
1
2
3
GRAIN SIZE
CLAY......SAND
COARSE SAND LITHOLOGY
LOCAL ACID BASIC CARB. QTZ.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LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY......SAND
HOLE 799E
ELEV. 1870
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA MG AL SI K CA TI FE
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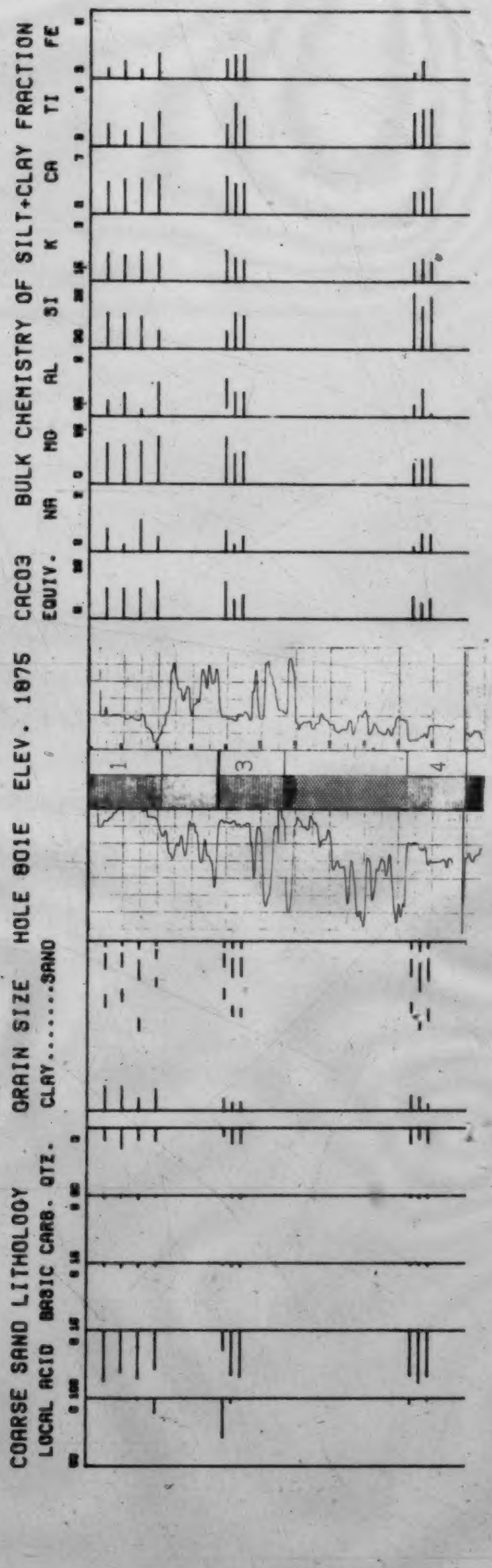
2
3
4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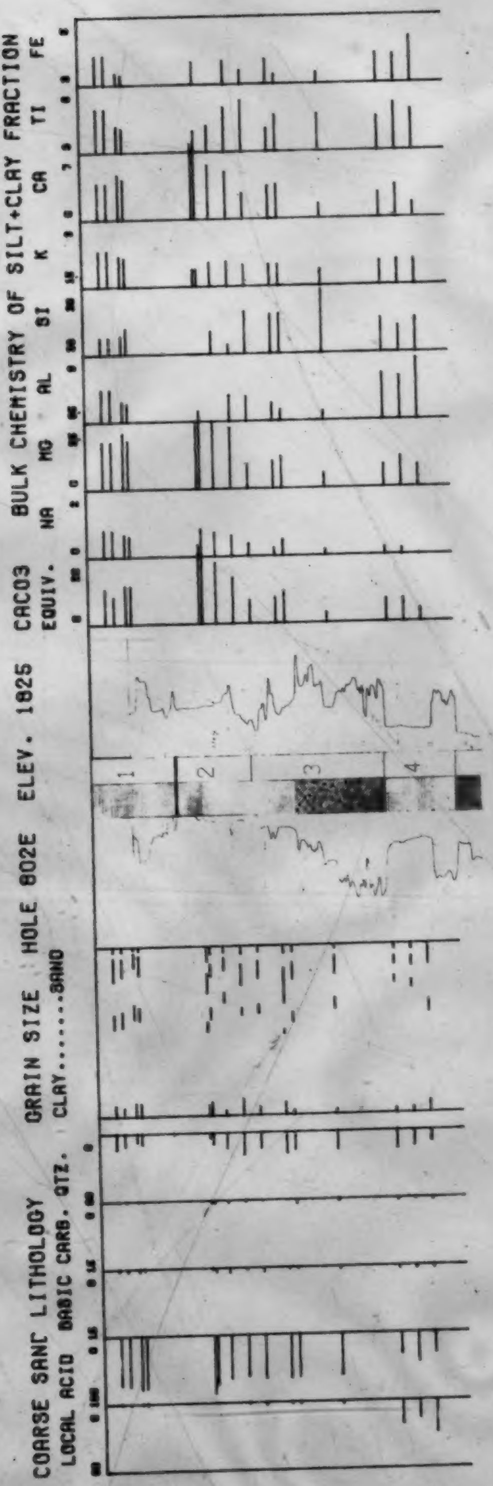
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY......SAND
HOLE 801E
ELEV. 1875
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MG
AL
SI
K
CA
TI
FE
1
3
4

5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LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY......SAND
HOLE 802E
ELEV. 1825
1
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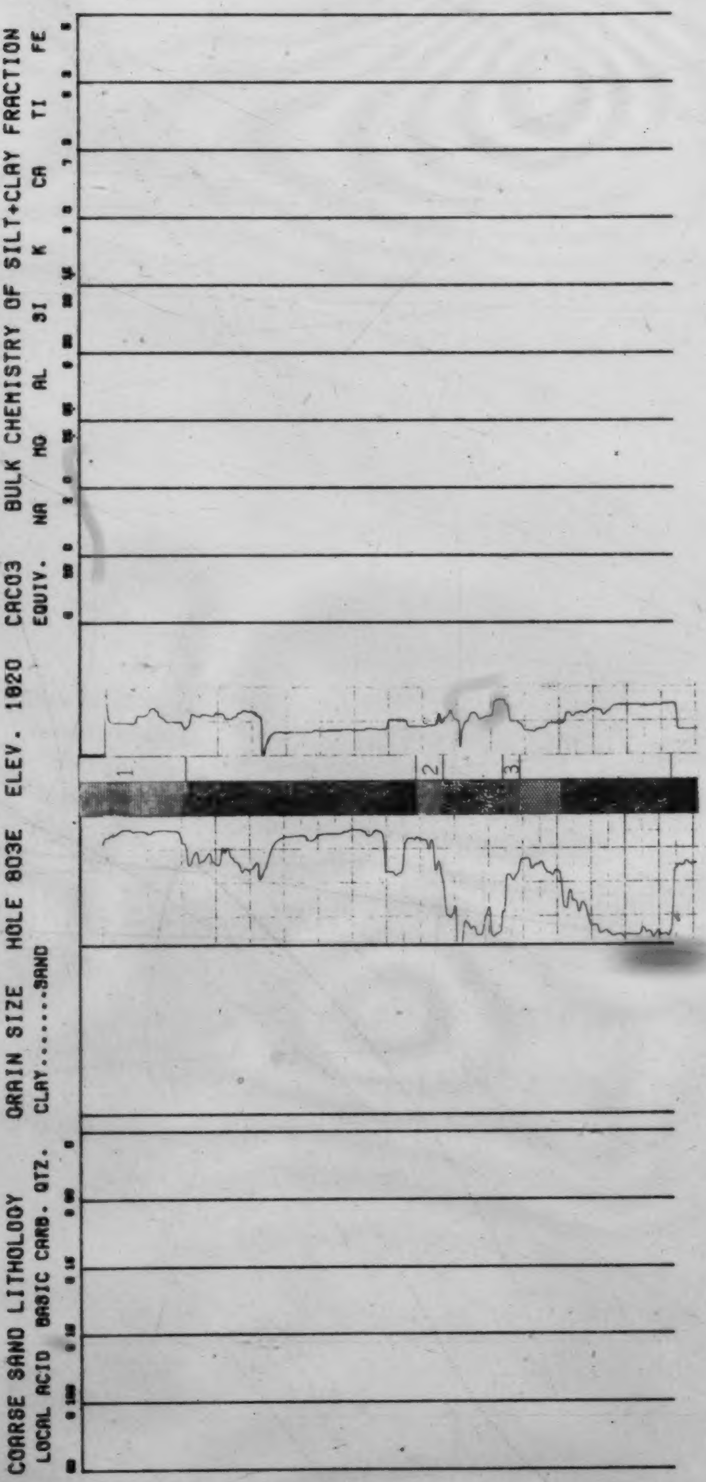
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MG
AL
SI
K
CA
TI
FE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LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY......SAND
HOLE 803E
ELEV. 1820
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2
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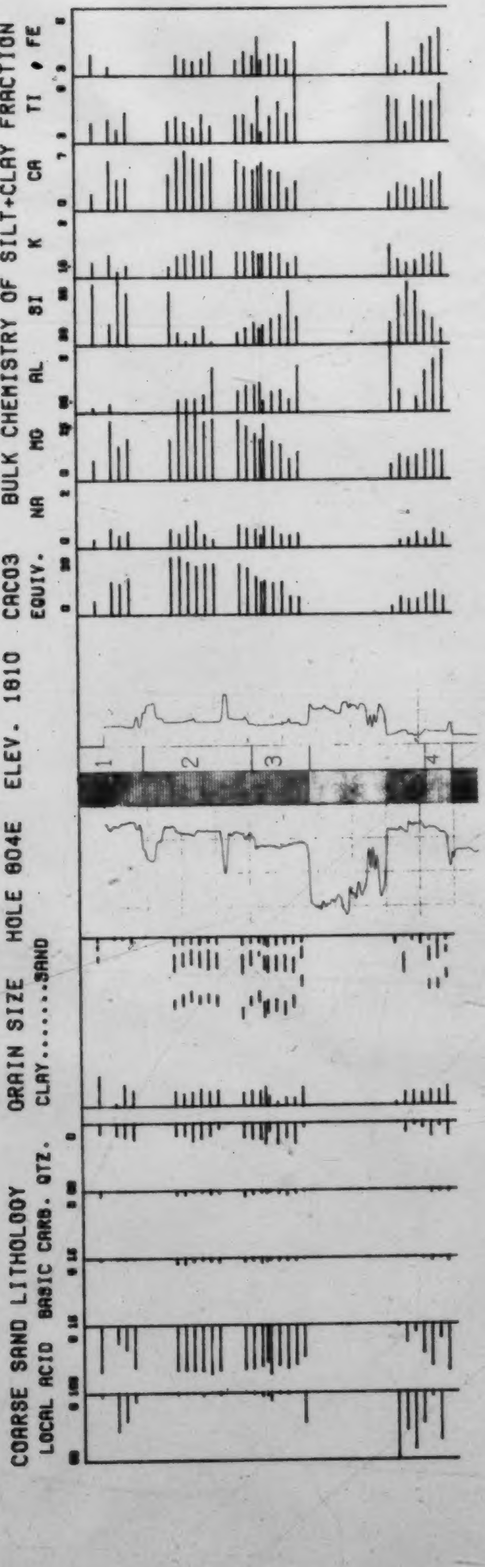
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA MG AL SI K CA TI FE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LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY......SAND
HOLE 804E ELEV. 1810
1
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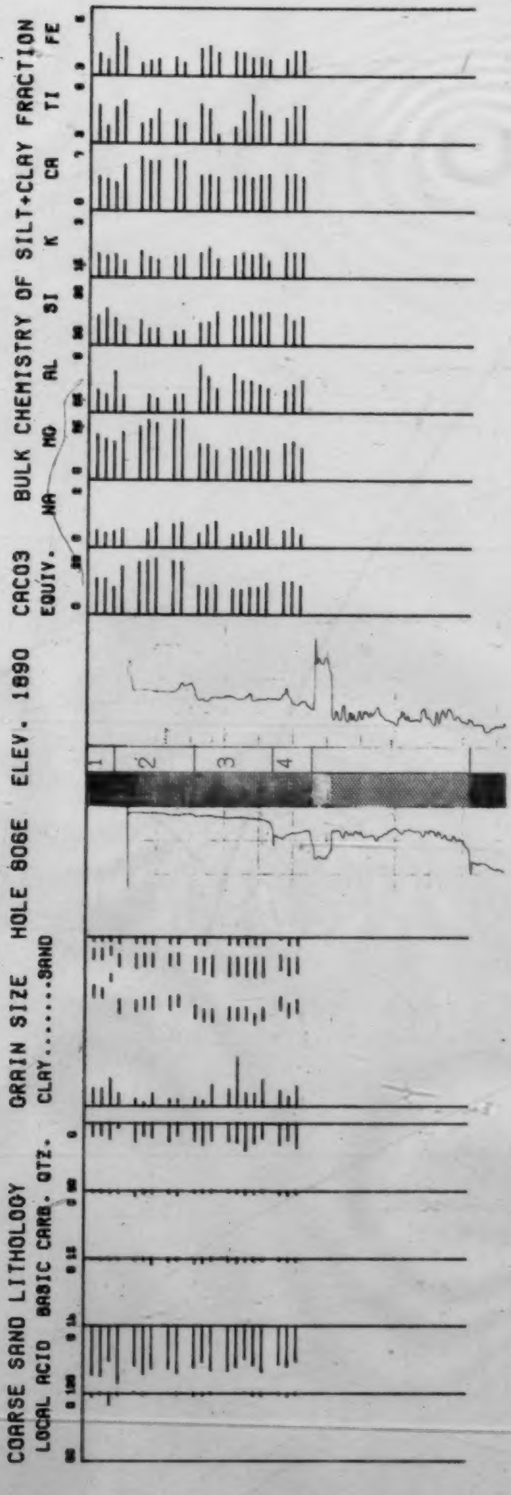
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MG
AL
SI
K
CA
TI
FE


COARSE SAND LITHOLOGY
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY......SAND
HOLE 806E ELEV. 1890
1
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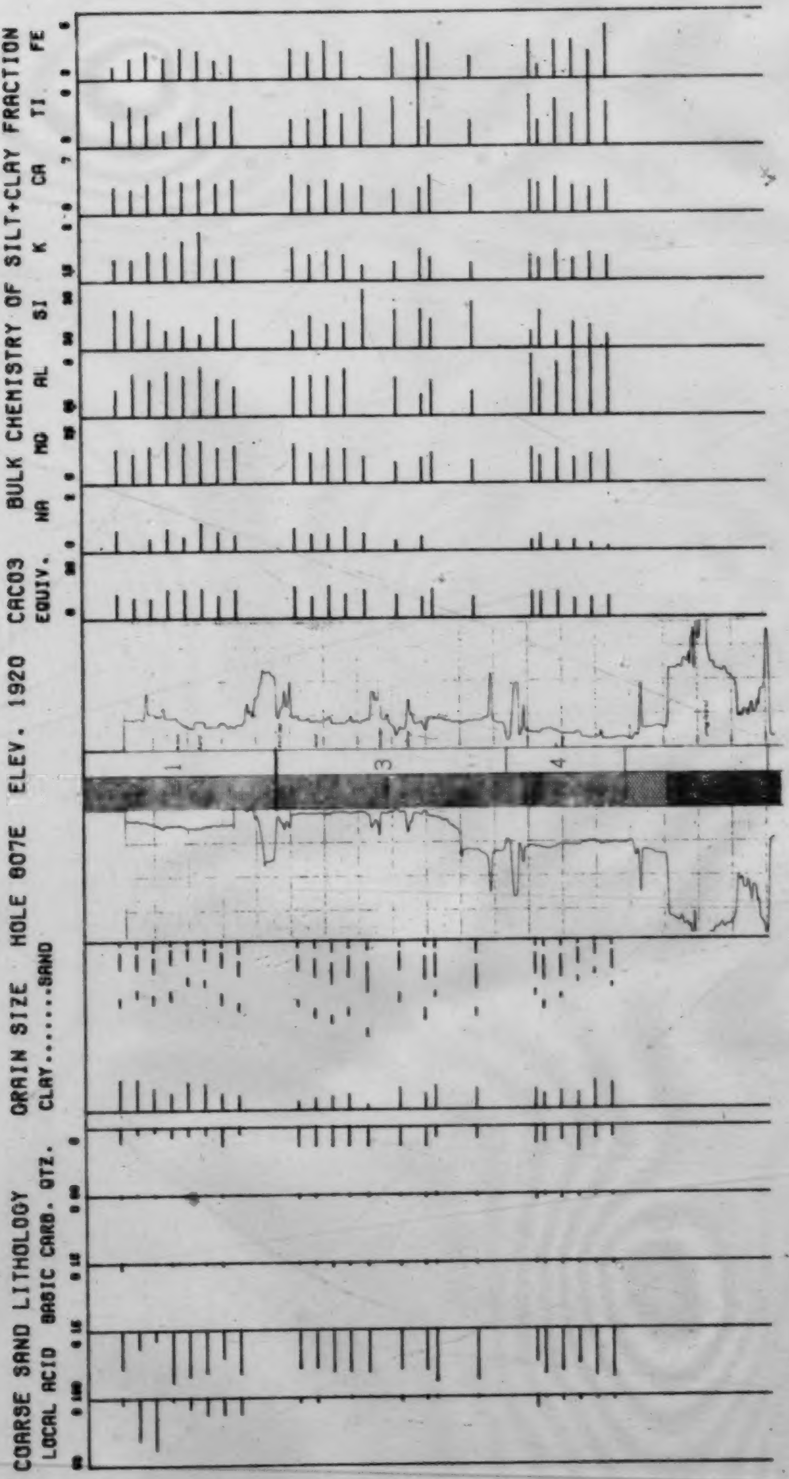
CACO3 EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MG
AL
SI
K
CA
TI
FE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LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY......SAND
HOLE 807E ELEV. 1920
1
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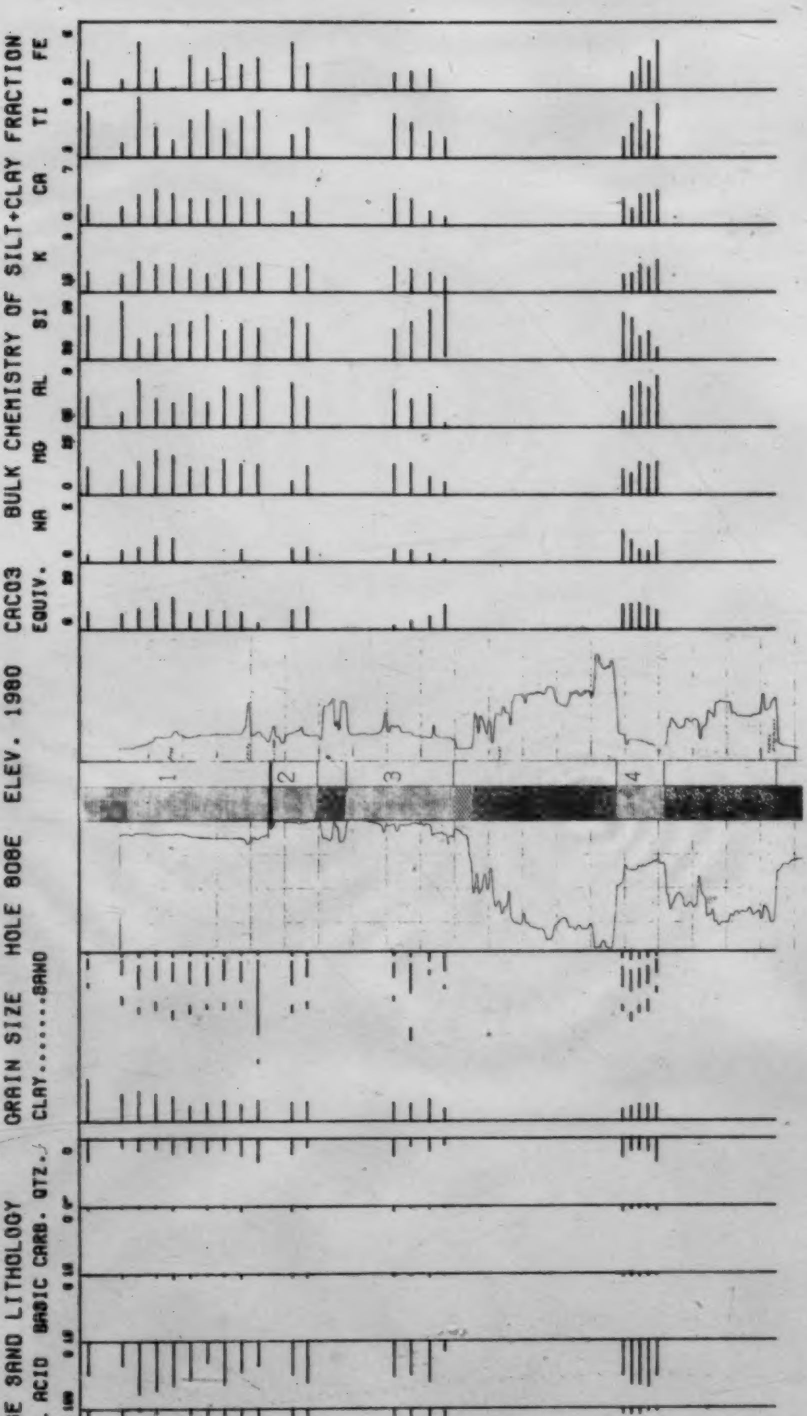
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA MG AL SI K CA TI FE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LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY......SAND
HOLE 808E
ELEV. 1980
CACO3
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BULK CHEMISTRY OF SILT+CLAY FRACTION
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MG
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K
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FE
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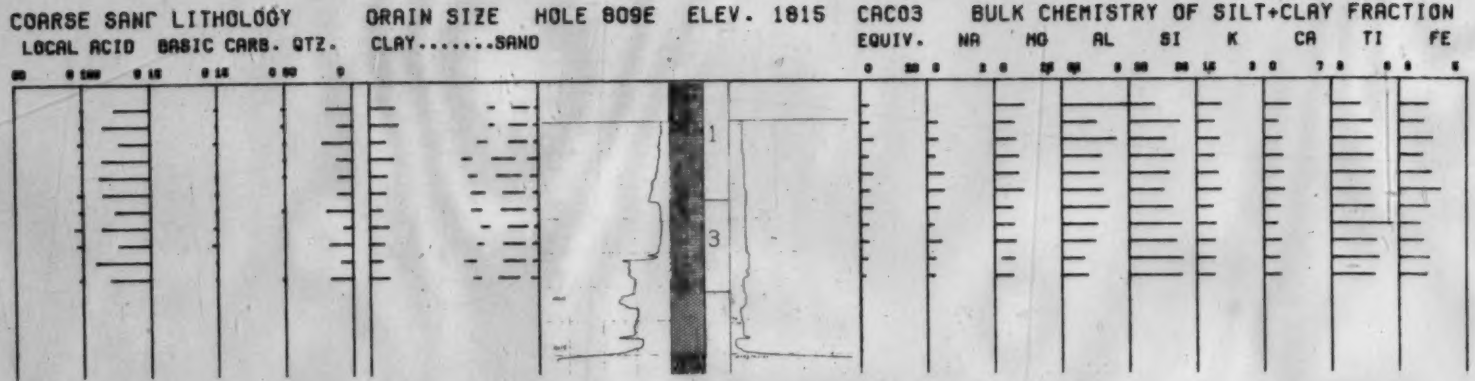
3
4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LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY.......SAND
HOLE 809E
ELEV. 1815
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BULK CHEMISTRY OF SILT+CLAY FRACTION
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MG
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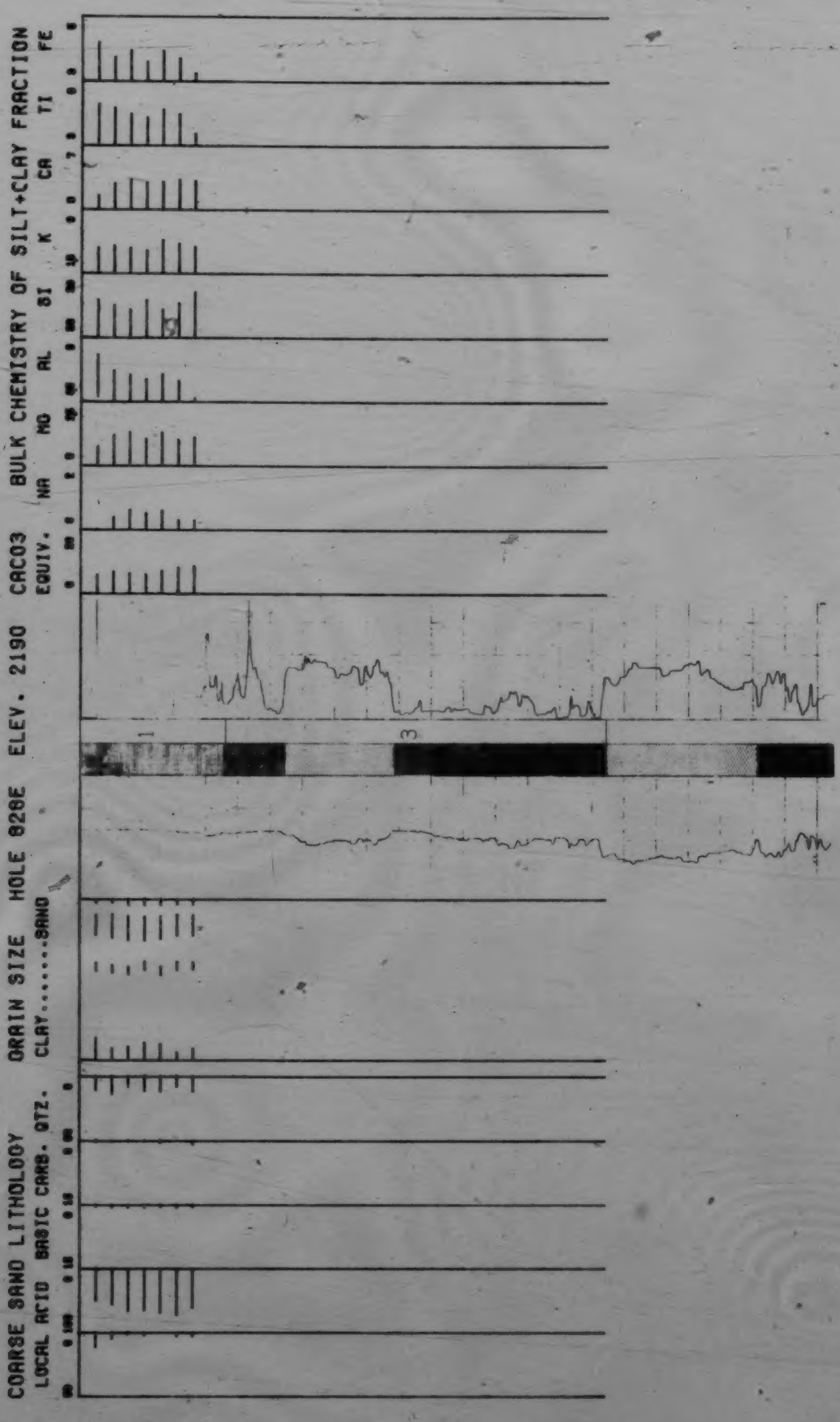
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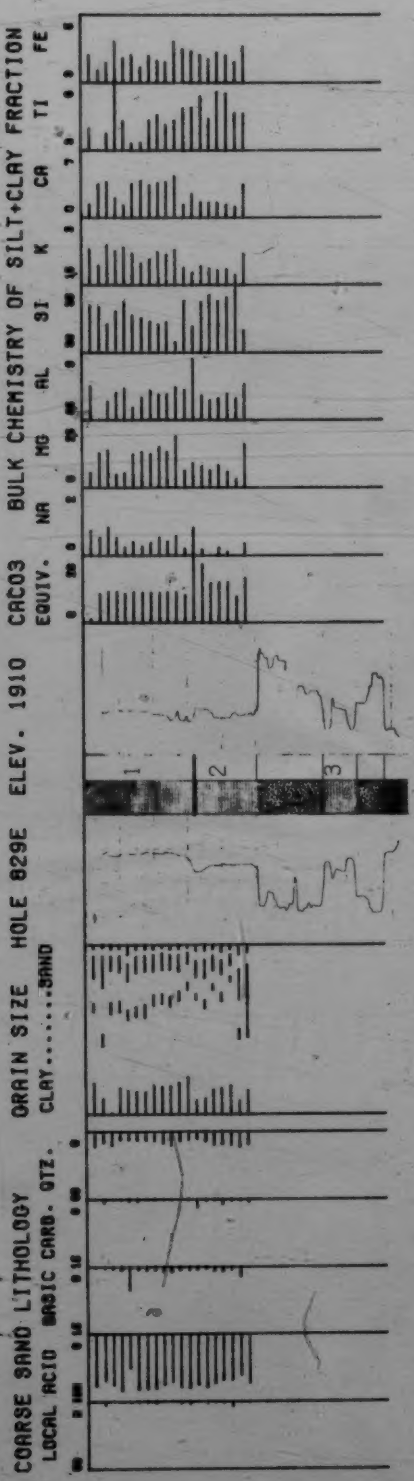
NA MG AL SI K CA TI FE
CACO3 EQUIV.
ELEV. 2190
HOLE 826E
GRAIN SIZE
CLAY......SAND
COARSE SAND LITHOLOGY
LOCAL ACID BASIC CARB. QTZ.
1
3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LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY.....SAND
HOLE 829E ELEV. 1910
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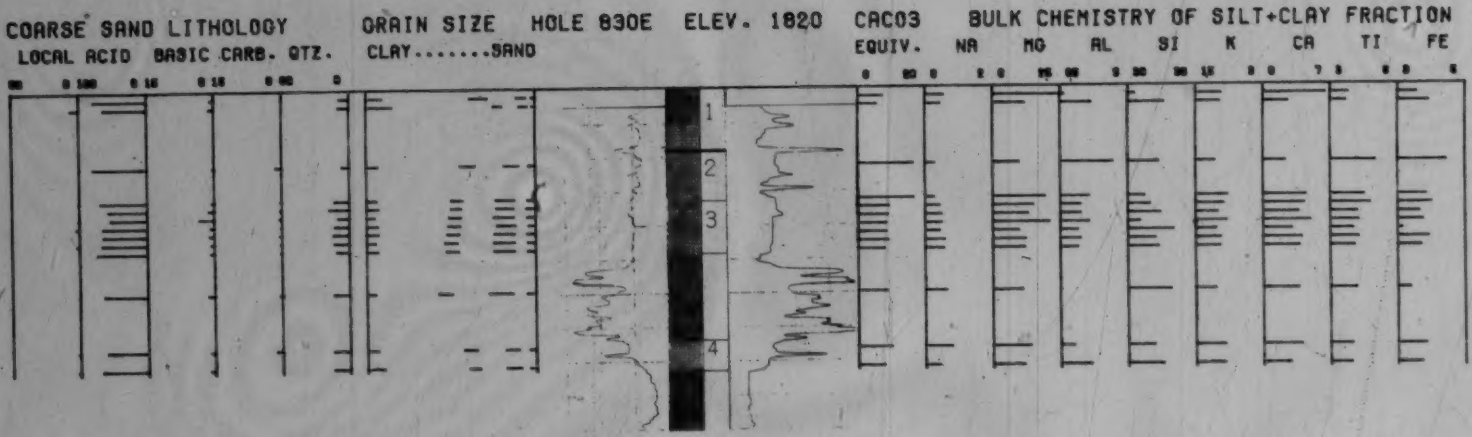
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA MG AL SI K CA TI FE


COARSE SAND LITHOLOGY
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY.......SAND
HOLE 830E
ELEV. 1820
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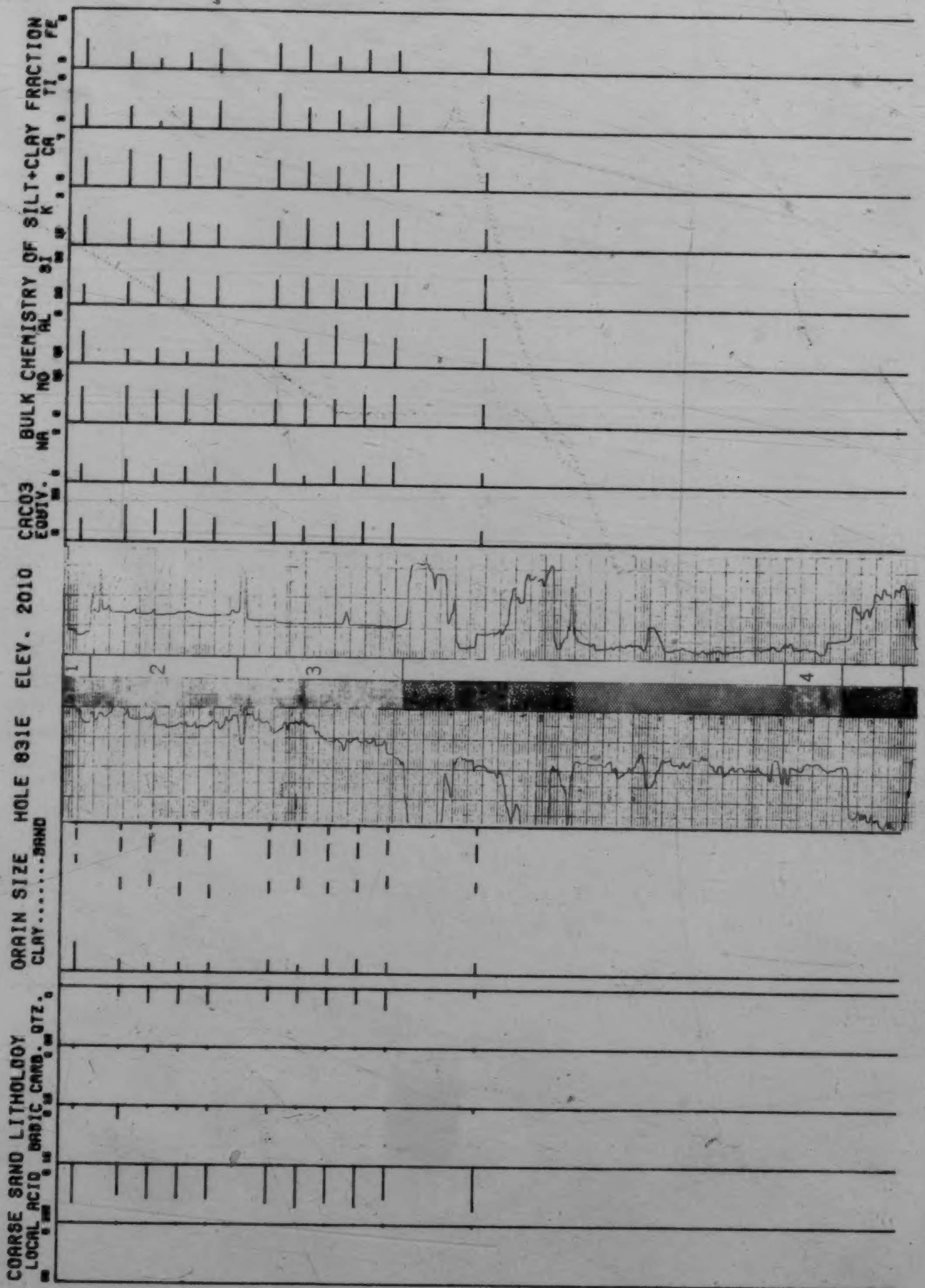
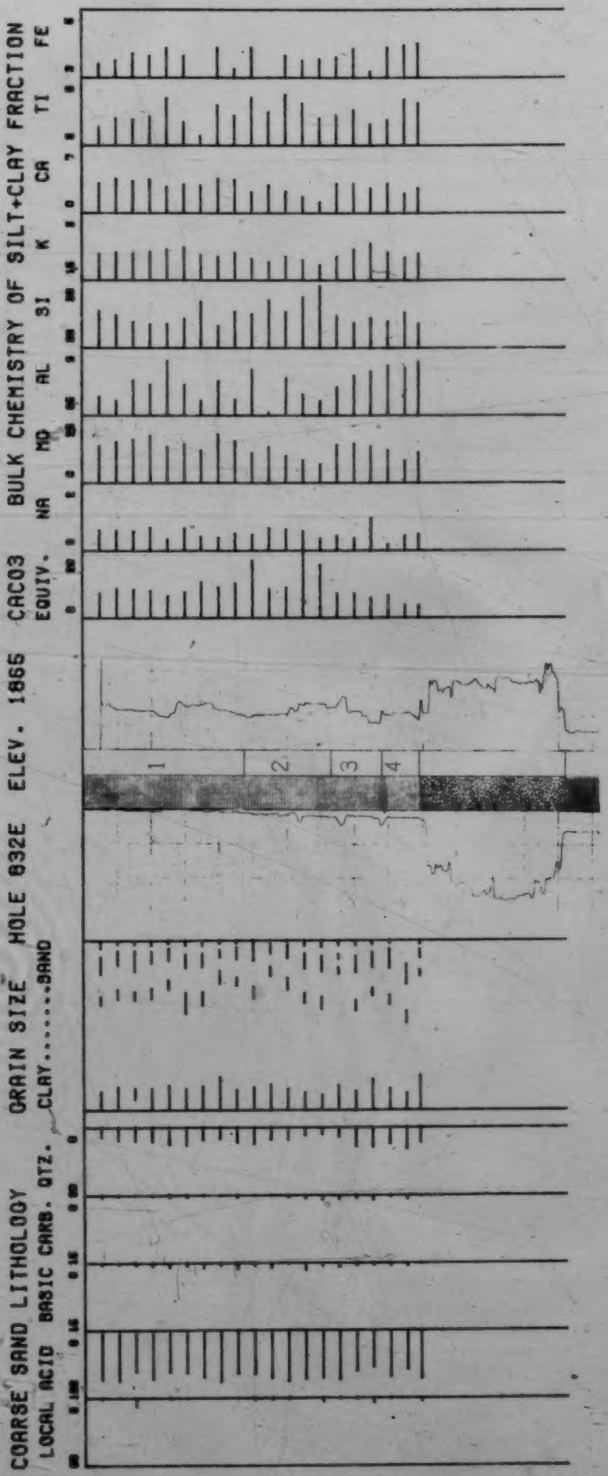
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MG
AL
SI
K
CA
TI
FE


BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MG
AL
SI
K
CA
TI
FE
CACO3
EQUIV.
HOLE 831E
ELEV. 2010
1
2
3
4
GRAIN SIZE
CLAY......SAND
COARSE SAND LITHOLOGY
LOCAL ACID
BASIC
CARB.
QTZ.


COARSE SAND LITHOLOGY
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY......SAND
HOLE 832E ELEV. 1865
1
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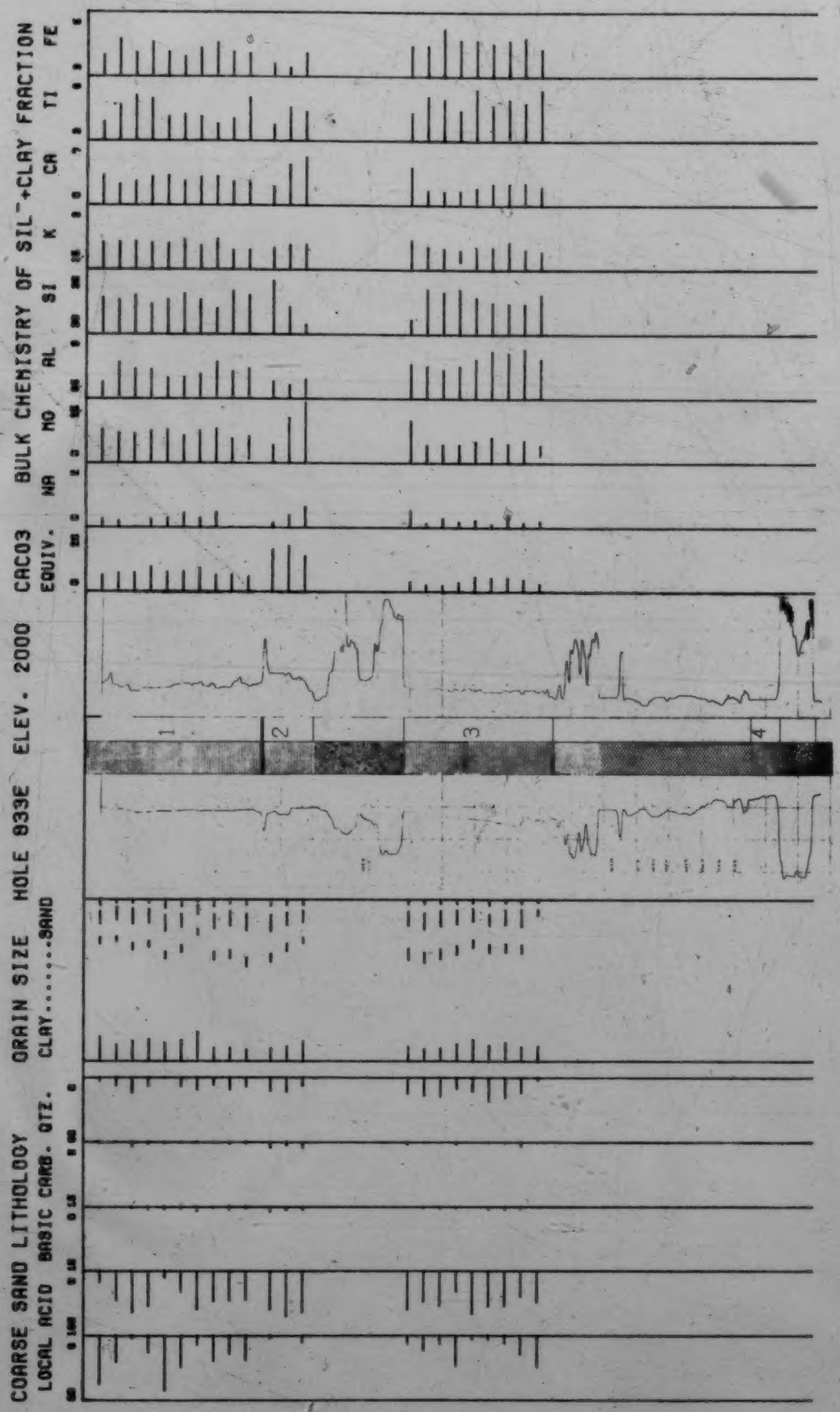
4
CACO3 EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MG
AL
SI
K
CA
TI
FE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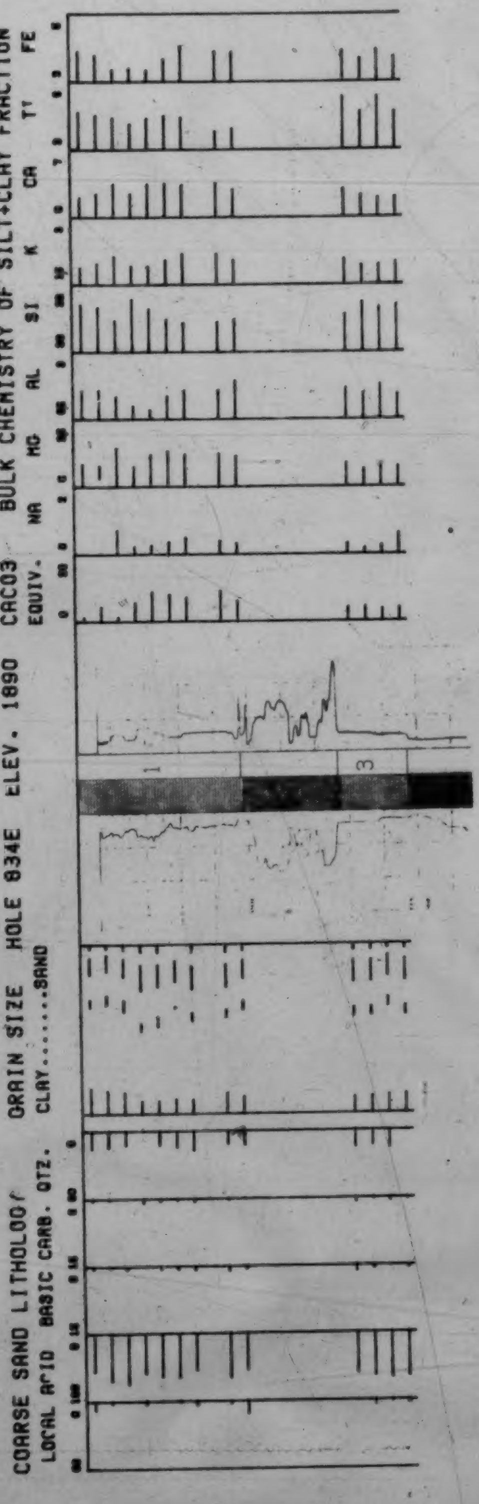
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY......SAND
HOLE 833E
ELEV. 2000
CACO3
EQUIV.
BULK CHEMISTRY OF SIL⁻+CLAY FRACTION
NA MG AL SI K CA TI FE
1
2
3
4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CACO3
EQUIV.
HOLE 834E ELEV. 1890
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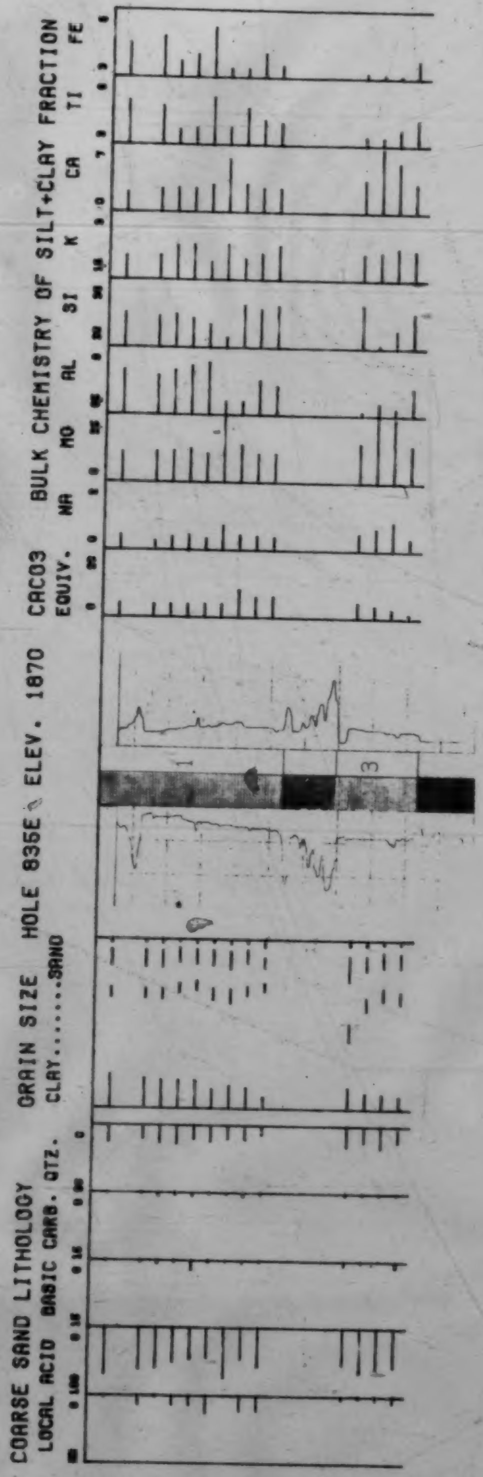
GRAIN SIZE
CLAY......SAND
COARSE SAND LITHOLOGY
LOCAL ACID BASIC CARB. QTZ.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LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY......SAND
HOLE 835E ELEV. 1870
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MG
AL
SI
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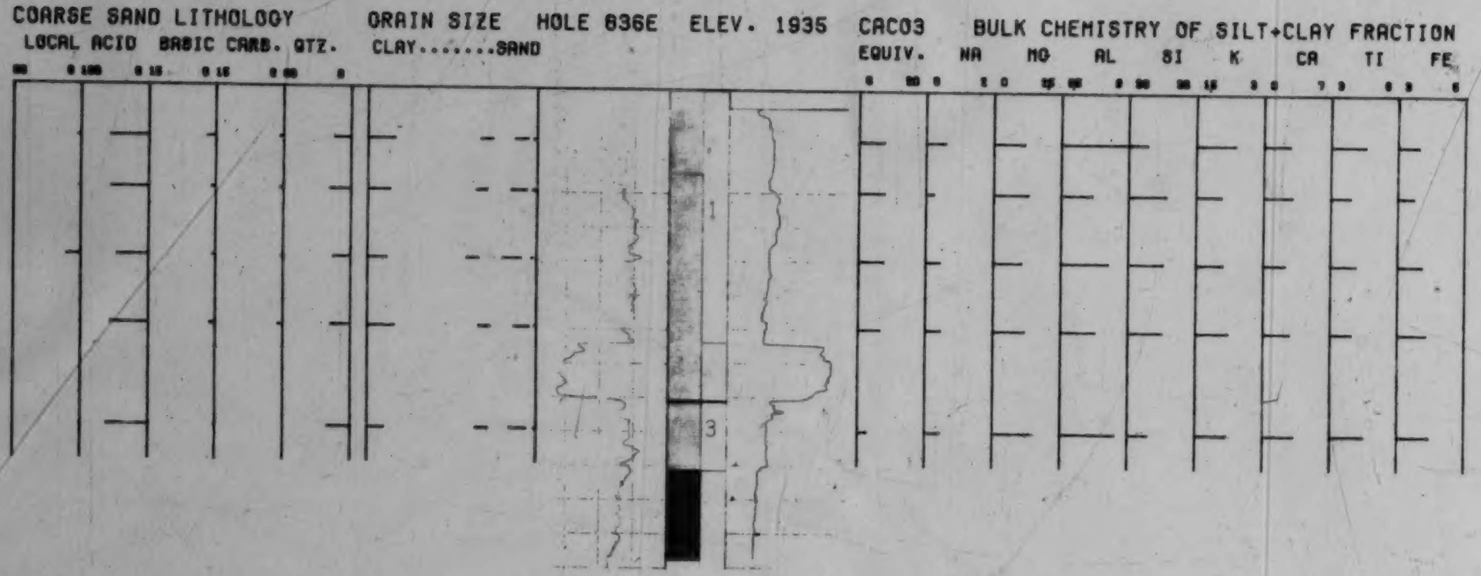
TI
FE
1
3


COARSE SAND LITHOLOGY
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY.......SAND
HOLE 836E
ELEV. 1935
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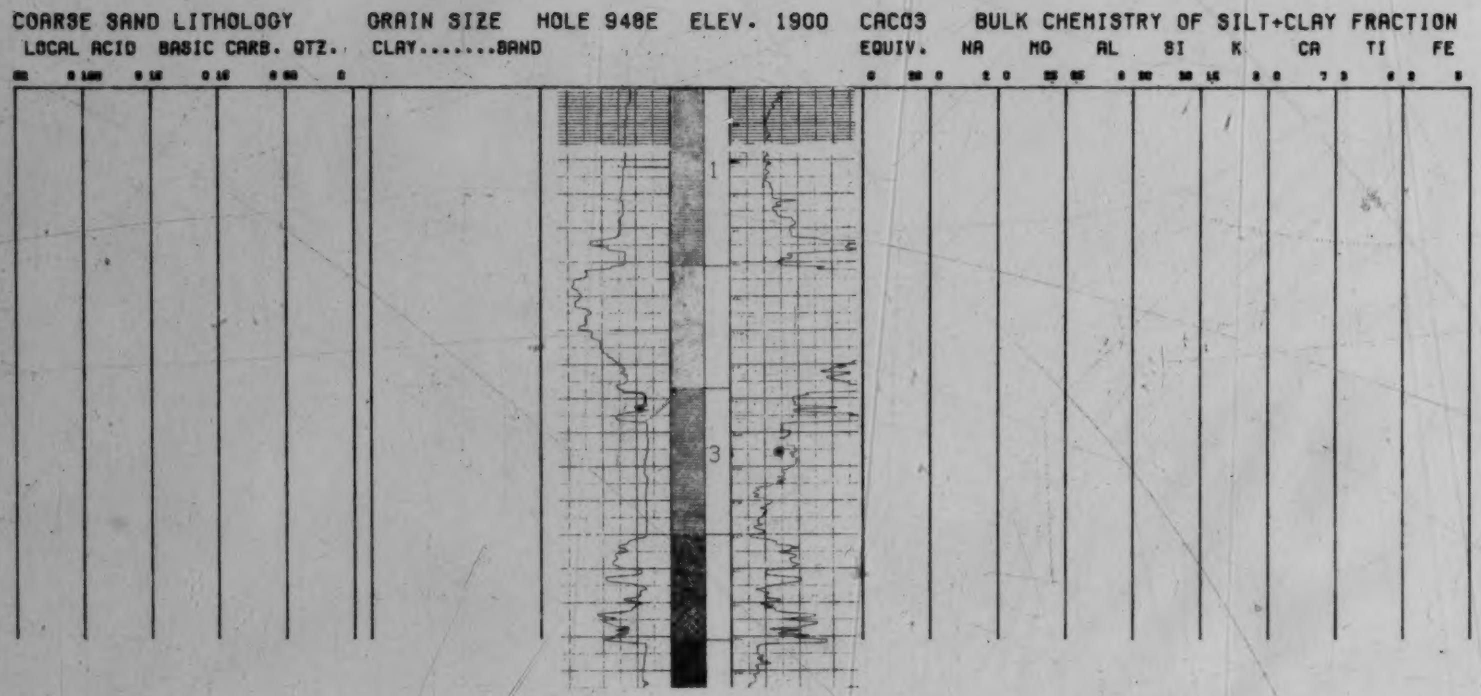
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MG
AL
SI
K
CA
TI
FE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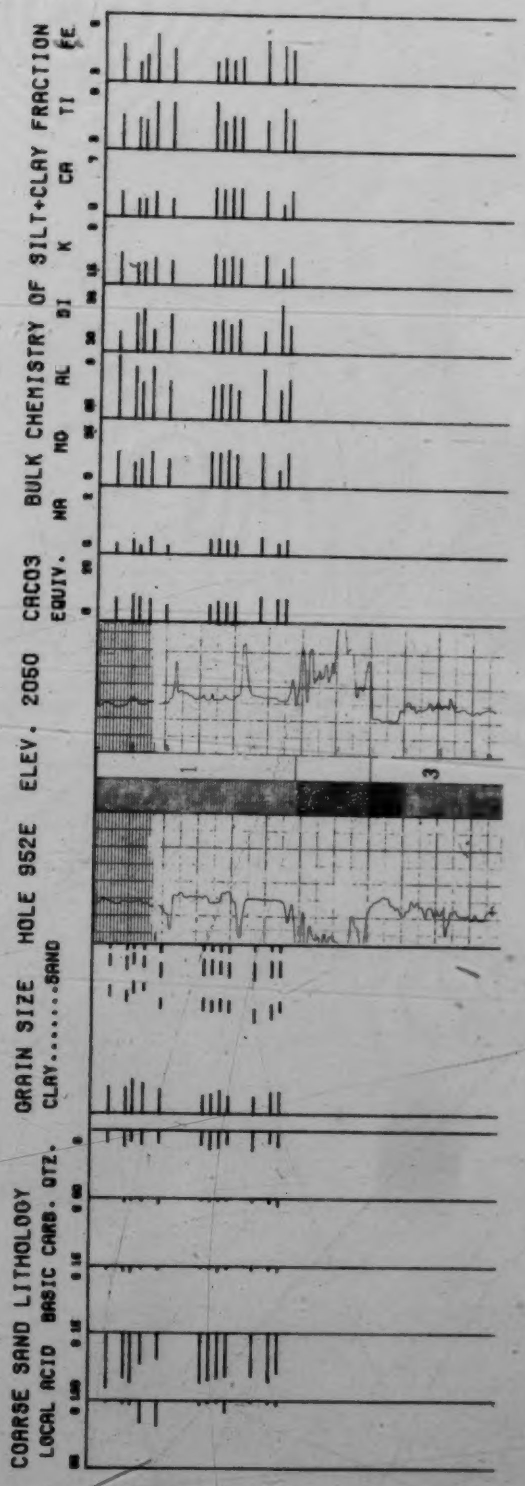
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY.......SAND
HOLE 948E
ELEV. 1900
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MG
AL
SI
K
CA
TI
FE
1
3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LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY......SAND
HOLE 952E
ELEV. 2050
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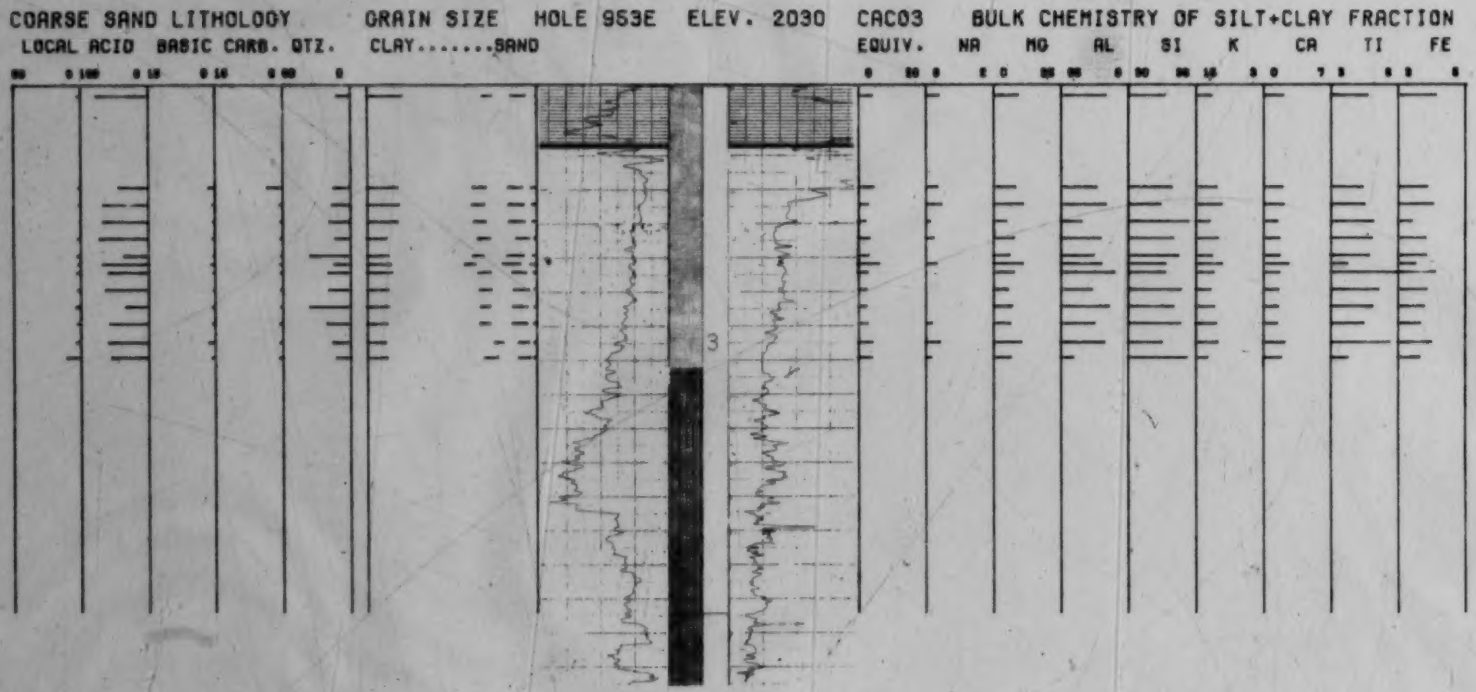
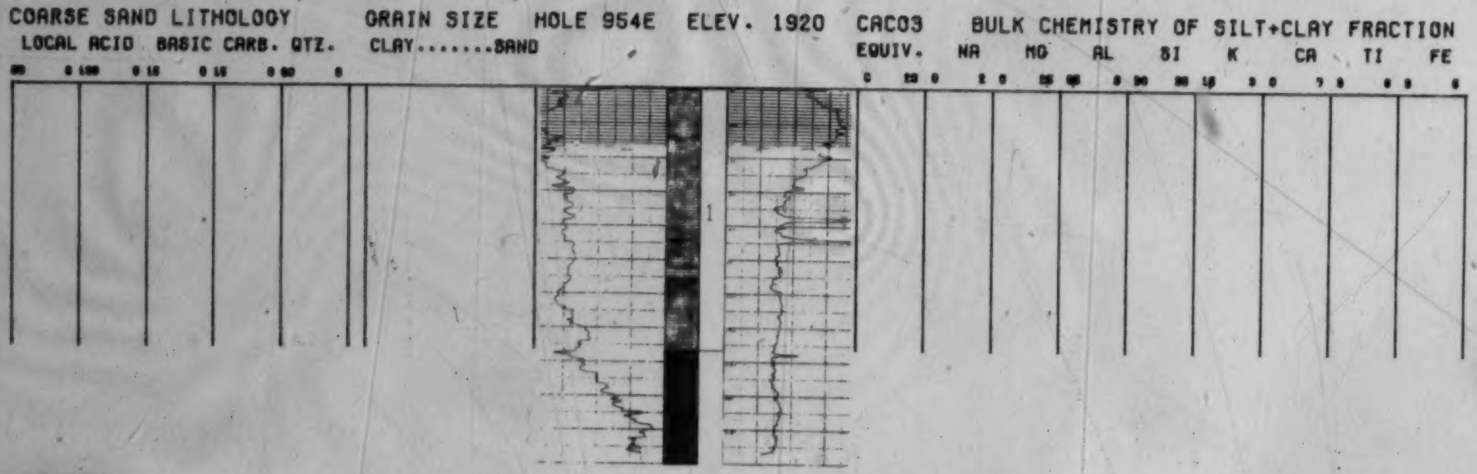
3
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MG
AL
SI
K
CA
TI
FE


COARSE SAND LITHOLOGY
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY.......SAND
HOLE 953E ELEV. 2030
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MG
AL
SI
K
CA
TI
FE
3


COARSE SAND LITHOLOGY
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY.......SAND
HOLE 954E ELEV. 1920
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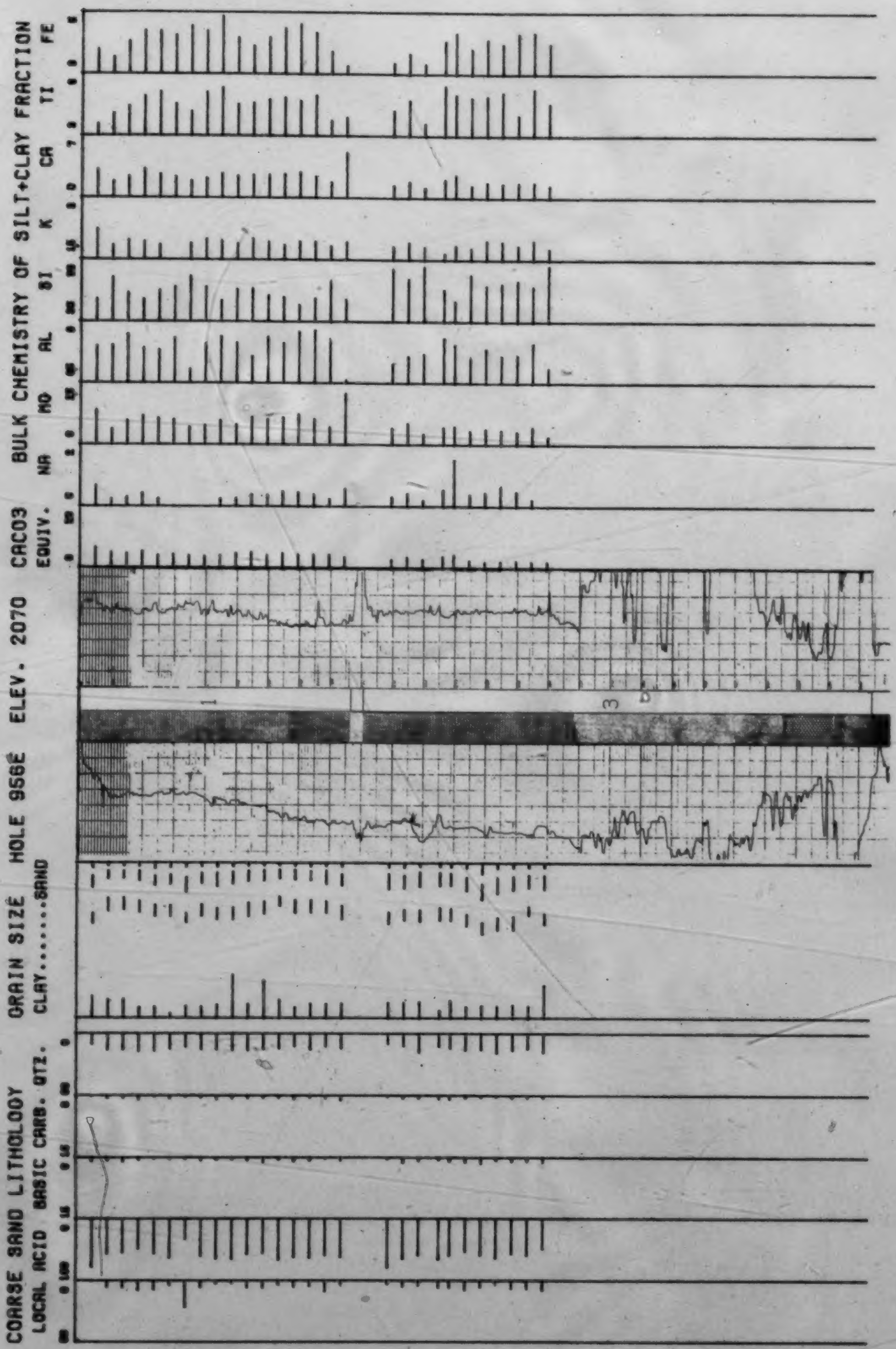
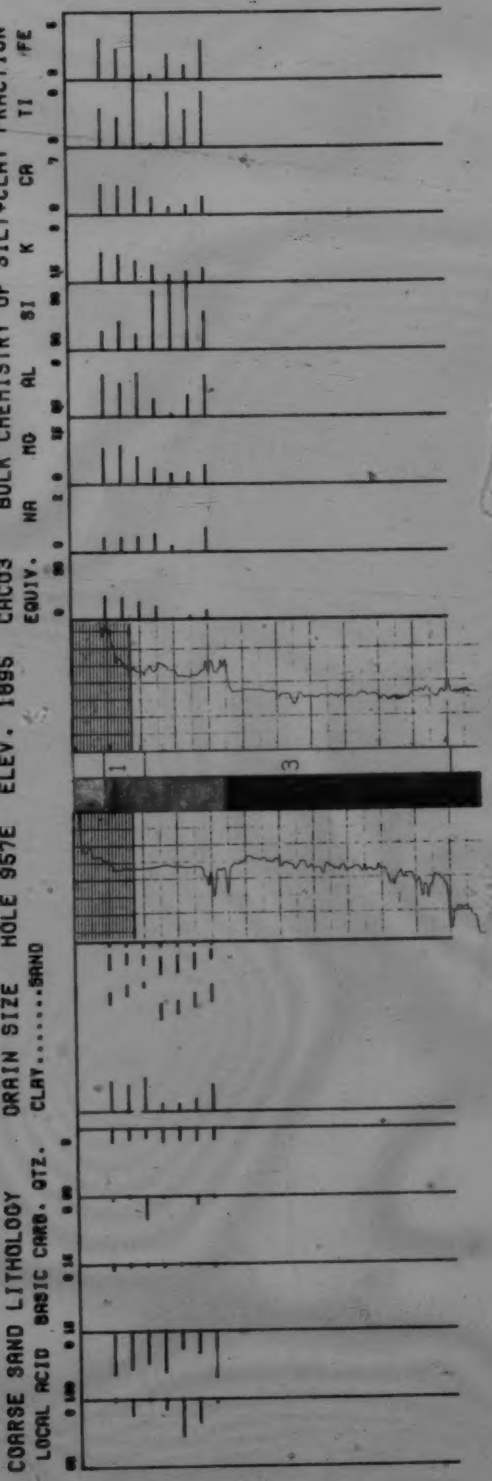
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MG
AL
SI
K
CA
TI
FE


BULK CHEMISTRY OF SILT+CLAY FRACTION
NA MG AL SI K CA TI FE
CACO3 EQUIV.
HOLE 956E ELEV. 2070
GRAIN SIZE
CLAY......SAND
COARSE SAND LITHOLOGY
LOCAL ACID BASIC CARB. QTZ.
1
3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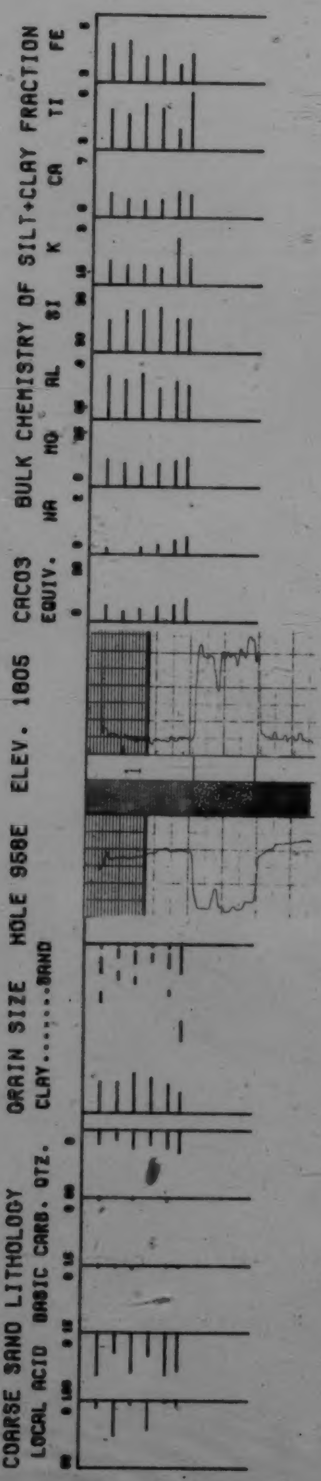
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY......SAND
HOLE 957E
ELEV. 1895
1
3
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA MG AL SI K CA TI FE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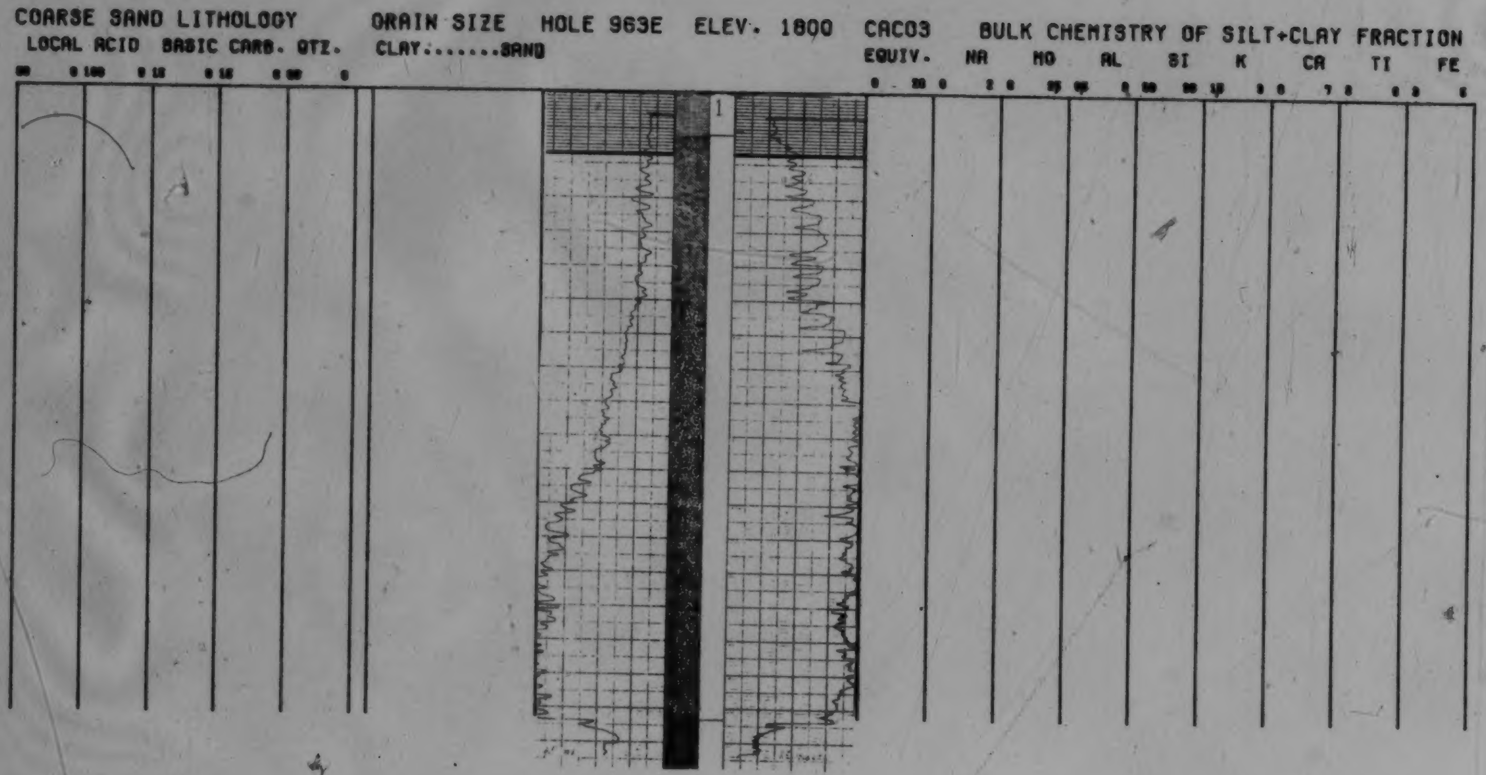
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY.......SAND
HOLE 958E ELEV. 1805
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA MG AL SI K CA TI FE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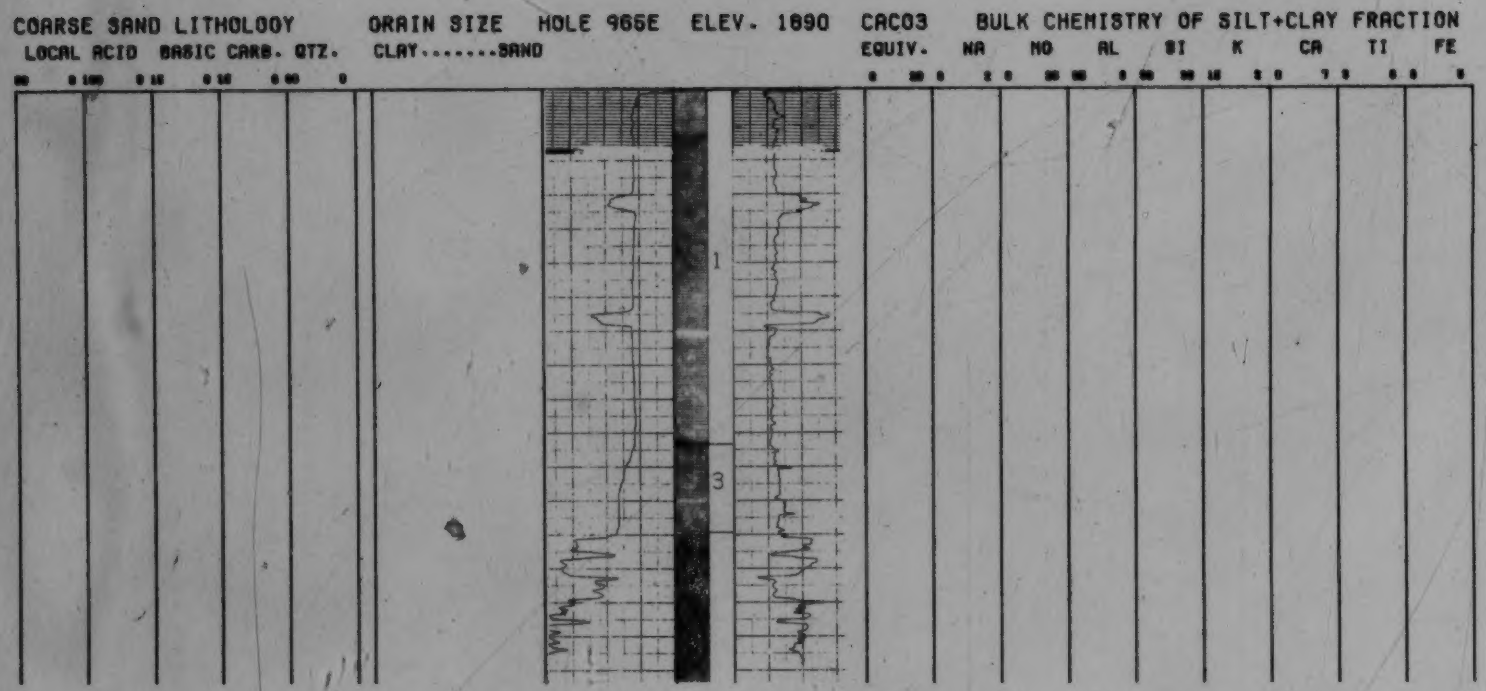
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY.......SAND
HOLE 963E
ELEV. 1800
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MO
AL
SI
K
CA
TI
FE
1


COARSE SAND LITHOLOGY
LOCAL ACID BASIC CARB. QTZ.
GRAIN SIZE
CLAY.......SAND
HOLE 965E ELEV. 1890
CACO3
EQUIV.
BULK CHEMISTRY OF SILT+CLAY FRACTION
NA
MG
AL
SI
K
CA
TI
FE
1
3

APPENDIX 5

Analysis of covariance for each analyzed variable, comparing between - units and within - units variance.

```
       S1020                            SUM OF                    MEAN             SIGNIF
SOURCE OF VARIATION                    SQUARES      DF          SQUARE        F      OF F

COVARIATES                             119.110       2          59.555   28.721     0.000
   EAST                                103.337       1         103.337   49.836     0.000
   NORTH                                13.327       1          13.327    6.427     0.011

MAIN EFFECTS                            33.194       3          11.065    5.336     0.001
   UNIT                                 33.194       3          11.065    5.336     0.001

EXPLAINED                              152.304       5          30.461   14.690     0.000

RESIDUAL                              2017.563     973           2.074

TOTAL                                 2169.867     978           2.219



       S2040                            SUM OF                    MEAN             SIGNIF
SOURCE OF VARIATION                    SQUARES      DF          SQUARE        F      OF F

COVARIATES                             112.989       2          56.494   15.721     0.000
   EAST                                 44.752       1          44.752   12.454     0.000
   NORTH                                64.748       1          64.748   18.018     0.000

MAIN EFFECTS                            12.796       3           4.265    1.187     0.314
   UNIT                                 12.796       3           4.265    1.187     0.314

EXPLAINED                              125.785       5          25.157    7.001     0.000

RESIDUAL                              3496.442     973           3.593

TOTAL                                 3622.227     978           3.704
```

```
      S4060                        SUM OF                 MEAN              SIGNIF
SOURCE OF VARIATION               SQUARES     DF         SQUARE      F       OF F

COVARIATES                        128.393      2         64.196    6.603    0.001
   EAST                            95.037      1         95.037    9.775    0.002
   NORTH                           29.886      1         29.886    3.074    0.080

MAIN EFFECTS                       48.757      3         16.252    1.672    0.171
   UNIT                            48.757      3         16.252    1.672    0.171

EXPLAINED                         177.152      5         35.430    3.644    0.003

RESIDUAL                         9460.211    973          9.723

TOTAL                            9637.363    978          9.854


      S60140                       SUM OF                 MEAN              SIGNIF
SOURCE OF VARIATION               SQUARES     DF         SQUARE      F       OF F

COVARIATES                        237.853      2        118.927    6.617    0.001
   EAST                           101.902      1        101.902    5.670    0.017
   NORTH                          128.535      1        128.535    7.151    0.008

MAIN EFFECTS                      237.301      3         79.100    4.401    0.004
   UNIT                           237.301      3         79.100    4.401    0.004

EXPLAINED                         475.156      5         95.031    5.207    0.000

RESIDUAL                        17488.281    973         17.974

TOTAL                           17963.438    978         18.368
```

```
     S140230                      SUM OF               MEAN             SIGNIF
SOURCE OF VARIATION              SQUARES     DF       SQUARE       F     OF F

COVARIATES                       190.571      2       95.285  23.277    0.000
   EAST                           62.518      1       62.518  15.272    0.000
   NORTH                         133.600      1      133.600  32.637    0.000

MAIN EFFECTS                      67.814      3       22.605   5.522    0.001
   UNIT                           67.814      3       22.605   5.522    0.001

EXPLAINED                        258.385      5       51.677  12.624    0.000

RESIDUAL                        3983.017    973        4.094

TOTAL                           4241.402    978        4.337
```

```
     SAND                         SUM OF               MEAN             SIGNIF
SOURCE OF VARIATION              SQUARES     DF       SQUARE       F     OF F

COVARIATES                      2508.261      2     1254.130  16.062    0.000
   EAST                          828.877      1      828.877  10.615    0.001
   NORTH                        1604.547      1     1604.547  20.549    0.000

MAIN EFFECTS                     319.521      3      106.507   1.364    0.252
   UNIT                          319.521      3      106.507   1.364    0.252

EXPLAINED                       2827.813      5      565.563   7.243    0.000

RESIDUAL                       75974.430    973       78.083

TOTAL                          78802.250    978       80.575
```

SILT SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	SIGNIF OF F
COVARIATES	1010.414	2	505.207	7.725	0.000
EAST	31.047	1	31.047	0.475	0.491
NORTH	967.497	1	967.497	14.794	0.000
MAIN EFFECTS	1660.122	3	553.374	8.462	0.000
UNIT	1660.121	3	553.374	8.462	0.000
EXPLAINED	2670.535	5	534.107	8.167	0.000
RESIDUAL	63632.527	973	65.398		
TOTAL	66303.063	978	67.795		

CLAY SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	SIGNIF OF F
COVARIATES	632.911	2	316.456	19.917	0.000
EAST	539.083	1	539.083	33.928	0.000
NORTH	80.161	1	80.161	5.045	0.025
MAIN EFFECTS	615.541	3	205.160	12.913	0.000
UNIT	615.541	3	205.180	12.913	0.000
EXPLAINED	1248.453	5	249.691	15.715	0.000
RESIDUAL	15459.918	973	15.889		
TOTAL	16708.371	978	17.084		

```
     CACO3                                  SUM OF                  MEAN              SIGNIF
SOURCE OF VARIATION                        SQUARES     DF         SQUARE       F        OF F

COVARIATES                                3161.477      2       1580.739 353.901    0.000
   EAST                                   3135.117      1       3135.117 701.900    0.000
   NORTH                                    47.452      1         47.452  10.624    0.001

MAIN EFFECTS                              3588.446      3       1196.149 267.798    0.000
   UNIT                                   3588.449      3       1196.149 267.798    0.000

EXPLAINED                                 6749.926      5       1[illegible]9.985 302.239    0.0

RESIDUAL                                  4346.016    973          4.467

TOTAL                                    11095.941    978         11.346



     LOCAL                                  SUM OF                  MEAN              SIGNIF
SOURCE OF VARIATION                        SQUARES     DF         SQUARE       F        OF F

COVARIATES                                5659.645      2       2829.822  24.489    0.000
   EAST                                   1144.250      1       1144.250   9.902    0.002
   NORTH                                  4369.512      1       4369.512  37.813    0.000

MAIN EFFECTS                              1996.949      3        666.316   5.766    0.001
   UNIT                                   1998.951      3        666.317   5.766    0.001

EXPLAINED                                 7658.625      5       1531.725  13.255    0.000

RESIDUAL                                112435.938    973        115.556

TOTAL                                   120094.563    978        122.796
```

ACID SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	SIGNIF OF F
COVARIATES	11779.867	2	5889.934	40.877	0.000
EAST	11314.367	1	11314.367	78.523	0.000
NORTH	332.239	1	332.239	2.306	0.129
MAIN EFFECTS	4747.895	3	1582.631	10.984	0.000
UNIT	4747.895	3	1582.631	10.984	0.000
EXPLAINED	16527.813	5	3305.563	22.941	0.000
RESIDUAL	140199.563	973	144.090		
TOTAL	156727.375	978	160.253		

BASIC SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	SIGNIF OF F
COVARIATES	159.475	2	79.738	7.719	0.000
EAST	147.072	1	147.072	14.237	0.000
NORTH	15.215	1	15.215	1.473	0.225
MAIN EFFECTS	112.527	3	37.509	3.631	0.013
UNIT	112.527	3	37.509	3.631	0.013
EXPLAINED	272.004	5	54.401	5.266	0.000
RESIDUAL	10051.227	973	10.330		
TOTAL	10323.230	978	10.555		

```
        CARB                        SUM OF                 MEAN              SIGNIF
SOURCE OF VARIATION                SQUARES      DF        SQUARE        F     OF F

COVARIATES                          14.226       2         7.113    0.357   0.700
   EAST                              0.145       1         0.145    0.007   0.933
   NORTH                            13.978       1        13.976    0.701   0.403

MAIN EFFECTS                       426.560       3       142.187    7.133   0.000
   UNIT                            426.560       3       142.187    7.133   0.000

EXPLAINED                          440.789       5        88.158    4.422   0.001

RESIDUAL                         19396.598     973        19.935

TOTAL                            19837.387     978        20.284



        QTZ                         SUM OF                 MEAN              SIGNIF
SOURCE OF VARIATION                SQUARES      DF        SQUARE        F     OF F

COVARIATES                        9293.383       2      4646.691   52.505   0.000
   EAST                           7233.090       1      7233.090   81.729   0.000
   NORTH                          2307.507       1      2307.507   26.073   0.000

MAIN EFFECTS                      4297.668       3      1432.556   16.187   0.000
   UNIT                           4297.664       3      1432.555   16.187   0.000

EXPLAINED                        13591.063       5      2718.212   30.714   0.000

RESIDUAL                         86110.875     973        88.500

TOTAL                            99701.938     978       101.945
```

```
        NA                                SUM OF               MEAN                SIGNIF
SOURCE OF VARIATION                       SQUARES     DF       SQUARE        F       OF F

COVARIATES                                  5.802      2        2.901    35.576    0.000
   EAST                                     3.976      1        3.976    48.758    0.000
   NORTH                                    1.997      1        1.997    24.494    0.000

MAIN EFFECTS                                0.691      3        0.230     2.824    0.038
   UNIT                                     0.691      3        0.230     2.824    0.038

EXPLAINED                                   6.492      5        1.298    15.925    0.000

RESIDUAL                                   79.335    973        0.082

TOTAL                                      85.828    978        0.088


        MG                                SUM OF               MEAN                SIGNIF
SOURCE OF VARIATION                       SQUARES     DF       SQUARE        F       OF F

COVARIATES                                 42.671      2       21.336   180.380    0.000
   EAST                                    36.329      1       36.329   [illegible].140    0.000
   NORTH                                    7.324      1        7.324    61.918    0.000

MAIN EFFECTS                               43.062      3       14.354   121.354    0.000
   UNIT                                    43.062      3       14.354   121.354    0.000

EXPLAINED                                  85.733      5       17.147   144.964    0.000

RESIDUAL                                  115.088    973        0.118

TOTAL                                     200.821    978        0.205
```

```
      AL                                  SUM OF                   MEAN              SIGNIF
SOURCE OF VARIATION                      SQUARES       DF         SQUARE       F       OF F

COVARIATES                                11.628        2          5.814   22.074    0.000
   EAST                                   11.554        1         11.554   43.076    0.000
   NORTH                                   0.144        1          0.144    0.546    0.460

MAIN EFFECTS                               9.104        3          3.035   11.524    0.000
   UNIT                                    9.104        3          3.035   11.524    0.000

EXPLAINED                                 20.732        5          4.146   15.746    0.000

RESIDUAL                                 256.225      973          0.263

TOTAL                                    276.957      978          0.283



      SI                                  SUM OF                   MEAN              SIGNIF
SOURCE OF VARIATION                      SQUARES       DF         SQUARE       F       OF F

COVARIATES                               119.691        2         59.845   60.945    0.000
   EAST                                  104.805        1        104.805  106.731    0.000
   NORTH                                  17.451        1         17.451   17.772    0.000

MAIN EFFECTS                             125.256        3         41.752   42.519    0.000
   UNIT                                  125.256        3         41.752   42.519    0.000

EXPLAINED                                244.947        5         48.989   49.890    0.000

RESIDUAL                                 955.444      973          0.982

TOTAL                                   1200.391      978          1.227
```

```
      K                                SUM OF                MEAN          SIGNIF
SOURCE OF VARIATION                   SQUARES    DF        SQUARE     F     OF F

COVARIATES                              0.186     2         0.093   2.851   0.058
   EAST                                 0.153     1         0.153   4.680   0.031
   NORTH                                0.038     1         0.038   1.163   0.281

MAIN EFFECTS                            0.919     3         0.306   9.389   0.000
   UNIT                                 0.919     3         0.306   9.389   0.000

EXPLAINED                               1.105     5         0.221   6.774   0.000

RESIDUAL                               31.741   973         0.033

TOTAL                                  32.846   978         0.034




      CA                               SUM OF                MEAN          SIGNIF
SOURCE OF VARIATION                   SQUARES    DF        SQUARE     F      OF F

COVARIATES                            198.232     2        99.116 155.792   0.000
   EAST                               192.403     1       192.403 302.423   0.000
   NORTH                                8.113     1         8.113  12.752   0.000

MAIN EFFECTS                          141.424     3        47.141  74.098   0.000
   UNIT                               141.424     3        47.141  74.098   0.000

EXPLAINED                             339.656     5        67.931 106.776   0.000

RESIDUAL                              619.029   973         0.636

TOTAL                                 958.685   978         0.980
```

```
      T1                         SUM OF                MEAN              SIGNIF
SOURCE OF VARIATION              SQUARES     DF       SQUARE       F      OF F

COVARIATES                         0.058      2        0.029    7.672   0.000
   EAST                            0.054      1        0.054   14.312   0.000
   NORTH                           0.005      1        0.005    1.286   0.257

MAIN EFFECTS                       0.223      3        0.074   19.644   0.000
   UNIT                            0.223      3        0.074   19.644   0.000

EXPLAINED                          0.281      5        0.056   14.855   0.000

RESIDUAL                           3.684    973        0.004

TOTAL                              3.966    978        0.004
```

```
      FE                         SUM OF                MEAN              SIGNIF
SOURCE OF VARIATION              SQUARES     DF       SQUARE       F      OF F

COVARIATES                         6.966      2        3.483   23.753   0.000
   EAST                            6.670      1        6.670   45.489   0.000
   NORTH                           0.390      1        0.390    2.661   0.103

MAIN EFFECTS                       2.566      3        0.855    5.833   0.001
   UNIT                            2.566      3        0.855    5.833   0.001

EXPLAINED                          9.532      5        1.906   13.001   0.000

RESIDUAL                         142.668    973        0.147

TOTAL                            152.199    978        0.156
```

APPENDIX 6

Principal components factor analysis of the 22 analyzed variables, showing the correlation matrix, the pre- and post- rotation factor matrices, the transformation matrix, final communalities for each variable, eigenvalues for each factor and the factscore coefficients.

```
CORRELATION COEFFICIENTS..

              S1020      S2040      S4060     S60140    S140230       SAND       SILT       CLAY      LOCAL       ACID      BASIC

S1020       1.00000    0.67476    0.38484    0.30998    0.06773    0.60143   -0.52570   -0.25087   -0.16818    0.16773    0.10429
S2040       0.67476    1.00000    0.53455    0.41844    0.17488    0.74450   -0.65504   -0.29560   -0.31198    0.17677    0.07511
S4060       0.38484    0.53455    1.00000    0.37864    0.07493    0.71728   -0.64907   -0.24956   -0.20980    0.15281    0.01557
S60140      0.30998    0.41844    0.37864    1.00000    0.34550    0.82375   -0.71547   -0.34325   -0.28560    0.07667    0.07364
S140230     0.06773    0.17488    0.07493    0.34550    1.00000    0.46711   -0.45767   -0.08642   -0.12948    0.04836    0.04885
SAND        0.60143    0.74450    0.71728    0.82375    0.46711    1.00000   -0.89607   -0.37148   -0.33148    0.16280    0.08395
SILT       -0.52570   -0.65504   -0.64907   -0.71547   -0.45767   -0.89607    1.00000   -0.08105    0.33490   -0.22936   -0.07693
CLAY       -0.25087   -0.29560   -0.24956   -0.34325   -0.08642   -0.37148   -0.08105    1.00000    0.04469    0.10676   -0.02786
LOCAL      -0.16818   -0.31198   -0.20980   -0.28560   -0.12948   -0.33148    0.33490    0.04469    1.00000   -0.57541   -0.19083
ACID        0.16773    0.17677    0.15281    0.07667    0.04836    0.16280   -0.22936    0.10676   -0.57541    1.00000    0.03680
BASIC       0.10429    0.07511    0.01557    0.07364    0.04885    0.08395   -0.07693   -0.02786   -0.19083    0.03680    1.00000
CARB        0.10547    0.07875   -0.03670    0.01358   -0.01572    0.02379   -0.00093   -0.05192   -0.15738   -0.25270   -0.02730
QTZ        -0.09785    0.08119    0.06381    0.20855    0.08217    0.14110   -0.07658   -0.15318   -0.30242   -0.50097   -0.13310
CACO3       0.32826    0.14084    0.04621    0.12488   -0.08148    0.13954   -0.07035   -0.16152   -0.19582    0.32666    0.17235
NA          0.08889    0.07343    0.00895    0.18188   -0.05675    0.09545   -0.00080   -0.20947   -0.08466   -0.00754    0.01975
MG          0.22810    0.04335   -0.01943    0.05635   -0.09222    0.04543   -0.00332   -0.08926   -0.12030    0.29649    0.11331
AL         -0.23153   -0.23294   -0.18200   -0.25555   -0.09452   -0.29687    0.19115    0.29627    0.09339   -0.12724   -0.07585
SI         -0.12787    0.05041    0.12693    0.05184    0.13585    0.08325   -0.07995   -0.01935    0.10568   -0.15496   -0.06634
K           0.08744    0.01140   -0.00422    0.02629   -0.20646   -0.02174    0.02490   -0.00326   -0.07603    0.04150   -0.00142
CA          0.31937    0.14128    0.00980    0.11476   -0.02549    0.13309   -0.07495   -0.14243   -0.16792    0.27355    0.12783
TI         -0.14759   -0.10057   -0.04558   -0.14596    0.01512   -0.12896    0.11763    0.05859    0.02942   -0.14579   -0.03233
FE         -0.19620   -0.17638   -0.17045   -0.17028   -0.36536   -0.22913    0.14598    0.19976    0.04627   -0.16349   -0.04507


               CARB        QTZ      CACO3         NA         MG         AL         SI          K         CA         TI         FE

S1020       0.10547   -0.09785    0.32826    0.08889    0.22810   -0.23153   -0.12787    0.08744    0.31937   -0.14759   -0.19620
S2040       0.07875    0.08119    0.14084    0.02343    0.04335   -0.23294    0.05041    0.01140    0.14128   -0.10057   -0.17638
S4060      -0.03670    0.06381    0.04621    0.00895   -0.01943   -0.18200    0.12693   -0.00422    0.00980   -0.04558   -0.17045
S60140      0.01358    0.20855    0.12488    0.18188    0.05635   -0.25555    0.05184    0.02629    0.11476   -0.14596   -0.17028
S140230    -0.01522    0.08217   -0.08148   -0.05675   -0.09222   -0.09452    0.13585   -0.20646   -0.02549    0.01512   -0.36536
SAND        0.02379    0.14110    0.13954    0.09545    0.04543   -0.29687    0.08325   -0.02174    0.13309   -0.12896   -0.22913
SILT       -0.00093   -0.07658   -0.07035   -0.00080   -0.00332    0.19115   -0.07995    0.02490   -0.07495    0.11763    0.14598
CLAY       -0.05192   -0.15318   -0.16152   -0.20947   -0.08926    0.29627   -0.01935   -0.00326   -0.14243    0.05859    0.19976
LOCAL      -0.15738   -0.30242   -0.19582   -0.08466   -0.12030    0.09339    0.10568   -0.07603   -0.16792    0.02942    0.04627
ACID       -0.25270   -0.50097    0.32666   -0.00754    0.29649   -0.12724   -0.15496    0.04150    0.27355   -0.14579   -0.16349
BASIC      -0.02730   -0.13310    0.17235    0.01975    0.11331   -0.07585   -0.06634   -0.00142    0.12783   -0.03233   -0.04507
CARB        1.00000    0.07060    0.09096    0.07487    0.03064    0.01593   -0.08563    0.01598    0.06728    0.08414    0.05679
QTZ         0.07060    1.00000   -0.28121    0.06904   -0.28460    0.08220    0.13038    0.02831   -0.22325    0.12986    0.13960
CACO3       0.09096   -0.28121    1.00000    0.23842    0.73707   -0.29681   -0.49960    0.17875    0.75633   -0.20947   -0.29057
NA          0.07487    0.06904    0.23842    1.00000    0.34461   -0.08109   -0.38371    0.40109    0.25202   -0.11856   -0.15346
MG          0.03064   -0.28460    0.73707    0.34461    1.00000   -0.19848   -0.74701    0.24789    0.89951   -0.28067   -0.21146
AL          0.01593    0.08220   -0.29681   -0.08109   -0.19848    1.00000   -0.29154    0.15337   -0.27763    0.26104    0.55511
SI         -0.08563    0.13038   -0.49960   -0.38371   -0.74701   -0.29154    1.00000   -0.39576   -0.72929    0.07640   -0.28548
K           0.01538    0.02831    0.17875    0.40109    0.24789    0.15337   -0.39576    1.00000    0.20419   -0.19874   -0.00714
CA          0.06728   -0.22325    0.75633    0.25202    0.89951   -0.27763   -0.72929    0.20419    1.00000   -0.29537   -0.20324
TI          0.08414    0.12986   -0.20947   -0.11856   -0.28067    0.26104    0.07640   -0.19874   -0.29537    1.00000    0.37772
FE          0.05679    0.13960   -0.29057   -0.15346   -0.21146    0.55511   -0.28548   -0.00714   -0.20324    0.37772    1.00000
```

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FACTOR MATRIX USING PRINCIPAL FACTOR, NO ITERATIONS


              FACTOR  1  FACT3R  2  FACTOR  3  FACTOR  4  FACTOR  5  FACTOR  6  FACTOR  7

S1020           0.69394   -0.04289    0.05694    0.01380    0.28143    0.35729   -0.17624
S2040           0.71882   -0.32287    0.10378    0.04752    0.15167    0.23618   -0.22591
S4060           0.59233   -0.38827    0.04951    0.06383   -0.03504    0.32747   -0.16607
S60140          0.68020   -0.34860    0.16909   -0.12240   -0.13595   -0.14217    0.27548
S140230         0.29273   -0.37498    0.00034    0.12852    0.07555   -0.37208    0.00489
SAND            0.86068   -0.46099    0.12599    0.00390    0.01872    0.06777    0.13893
SILT           -0.74693    0.45492   -0.12302   -0.28364    0.05025   -0.10651   -0.18891
CLAY           -0.36895    0.07938   -0.01617    0.58553   -0.14449    0.07379    0.09276
LOCAL          -0.45458    0.04057   -0.23220   -0.34902    0.24803    0.57045    0.45544
ACID            0.39150    0.24389   -0.28528    0.66497   -0.27678   -0.11150   -0.20850
BASIC           0.17940    0.09679   -0.05704    0.14441    0.17365   -0.30540   -0.04741
CARB            0.04739    0.02924    0.32374   -0.22160    0.48348   -0.19768   -0.33587
QTZ            -0.04650   -0.40122    0.51245   -0.39308   -0.19698   -0.33570   -0.09893
CACO3           0.53169    0.65231   -0.11182   -0.02342    0.16935   -0.09204   -0.03265
NA              0.26116    0.35231    0.31206   -0.39724   -0.35973   -0.03316    0.05524
MG              0.45676    0.80132    0.01947   -0.00820    0.10513   -0.04452    0.14314
AL             -0.46308    0.02431    0.59349    0.35201   -0.04798    0.21083    0.09604
SI             -0.19755   -0.76249   -0.50843   -0.13589   -0.08282   -0.05400   -0.17708
K               0.13001    0.38984    0.39176   -0.13764   -0.51275    0.27428   -0.10755
CA              0.53397    0.73244    0.02192   -0.01887    0.19556   -0.08186    0.13175
TI             -0.33834   -0.25374    0.32672    0.18307    0.30458   -0.10448   -0.10178
FE             -0.41284   -0.04551    0.61776    0.34371    0.20453    0.06605    0.09959


    VARIMAX ROTATED FACTOR MATRIX


              FACTOR  1  FACT3R  2  FACTOR  3  FACTOR  4  FACTOR  5  FACTOR  6  FACTOR  7

S1020           0.76999    0.30475   -0.10018   -0.05529    0.10366   -0.11861   -0.03243
S2040           0.84844    0.04223   -0.10128   -0.02913    0.12729    0.00889    0.12156
S4060           0.78278   -0.11767   -0.10106    0.05508   -0.04104    0.00196    0.05148
S60140          0.53560    0.00983   -0.18474    0.21273    0.09040    0.59762    0.10330
S140230         0.13377   -0.02247   -0.00372   -0.20554   -0.05268    0.82931    0.04040
SAND            0.85964    0.01856   -0.16366    0.05770    0.06066    0.45828    0.09559
SILT           -0.80779    0.01626   -0.01699    0.00684    0.17352   -0.44746   -0.16293
CLAY           -0.23589   -0.07442    0.41723   -0.14042   -0.49590   -0.08835    0.12253
LOCAL          -0.21722   -0.04324   -0.00443   -0.13698   -0.10909   -0.09517   -0.94318
ACID            0.18490    0.27268   -0.09751   -0.09278   -0.57576   -0.10961    0.63142
BASIC          -0.00367    0.21887   -0.05282   -0.20378    0.08403    0.10745    0.28371
CARB            0.06331    0.13539    0.12175   -0.11018    0.86491   -0.14129    0.11110
QTZ            -0.00719   -0.42486    0.09816    0.39166    0.53633    0.27999    0.15539
CACO3           0.10349    0.80009   -0.27644    0.03990    0.02490   -0.07853    0.15512
NA             -0.01528    0.27727   -0.13992    0.67493    0.14969    0.02015   -0.00739
MG             -0.00399    0.91111   -0.13326    0.17638   -0.04819   -0.00580    0.05798
AL             -0.15158   -0.11713    0.80582    0.16226   -0.09722   -0.08579   -0.07876
SI              0.05561   -0.80523   -0.40577   -0.34797   -0.01847    0.02231   -0.02151
K               0.06226    0.18410    0.10001    0.76125   -0.10658   -0.22119    0.01338
CA              0.07637    0.91444   -0.15293    0.10430    0.02885    0.04071    0.07734
TI             -0.06578   -0.21349    0.49445   -0.29166    0.29900   -0.01778    0.04610
FE             -0.11698   -0.08494    0.83482   -0.03166    0.10319    0.01163   -0.04209


TRANSFORMATION MATRIX

              FACTOR  1  FACT3R  2  FACTOR  3  FACTOR  4  FACTOR  5  FACTOR  6  FACTOR  7

FACTOR  1       0.74967    0.41511   -0.34534    0.12922    0.01448    0.26255    0.24599
FACTOR  2      -0.39821    0.82318   -0.01804    0.23511   -0.11363   -0.31580    0.02206
FACTOR  3       0.14861    0.05334    0.73318    0.48754    0.42272    0.12527    0.07377
FACTOR  4       0.12508    0.07881    0.51848   -0.37405   -0.59797   -0.01384    0.46005
FACTOR  5       0.12242    0.32537    0.18684   -0.72974    0.49409   -0.05613   -0.23256
FACTOR  6       0.45092   -0.02956    0.16101    0.13467   -0.33591   -0.47816   -0.64051
FACTOR  7      -0.15310    0.19428    0.11498   -0.00292   -0.30603    0.76398   -0.49831
```

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VARIABLE        MEAN     STANDARD DEV    CASES     COMMUNALITY              FACTOR      EIGENVALUF   PCT OF VAR   CUM PCT

S1020          3.1363        1.5109        995       0.72473                    1         5.12665        23.3        23.3
S2040          5.3427        1.9480        995       0.76380                    2         3.73165        16.8        40.1
S4050          8.7190        3.1687        995       0.64418                    3         1.93412         8.8        48.9
S60140        14.7073        4.3612        995       0.74235                    4         1.71381         7.8        56.7
S140230        5.7508        2.1169        995       0.75282                    5         1.22749         5.6        62.3
SAND          37.6582        9.1969        995       0.99228                    6         1.20968         5.5        67.8
SILT          51.4538        8.5587        995       0.91000                    7         1.13463         5.2        72.9
CLAY          10.8831        4.1371        995       0.52039                    8         0.95712         4.4        77.3
LOCAL          7.3063       11.7976        995       0.97837                    9         0.93713         4.3        81.5
ACID          59.0962       12.8700        995       0.86883                   10         0.78501         3.6        85.1
BASIC          4.2544        3.2475        995       0.19133                   11         0.65858         3.0        88.1
CARB           4.0168        4.4792        995       0.52371                   12         0.59354         2.7        90.8
QTZ           25.3226       10.1339        995       0.73378                   13         0.49009         2.2        93.0
CACO3          6.7586        3.3571        995       0.75947                   14         0.47285         2.1        95.1
NA             0.3125        0.2949        995       0.58108                   15         0.38936         1.8        96.9
MG             1.0519        0.4511        995       0.88472                   16         0.28885         1.3        98.2
AL             7.6266        0.5492        995       0.73539                   17         0.25396         1.2        99.4
SI            33.1073        1.1366        995       0.93852                   18         0.09641         0.4        99.8
K              2.0373        0.2051        995       0.68774                   19         0.04945         0.2       100.0
CA             2.9059        0.9876        995       0.88474                   20         0.00257         0.0       100.0
TI             0.4441        0.0642        995       0.47130                   21         0.00000         0.0       100.0
FE             3.6204        0.4002        995       0.72839                   22        -0.00279        -0.0       100.0
```

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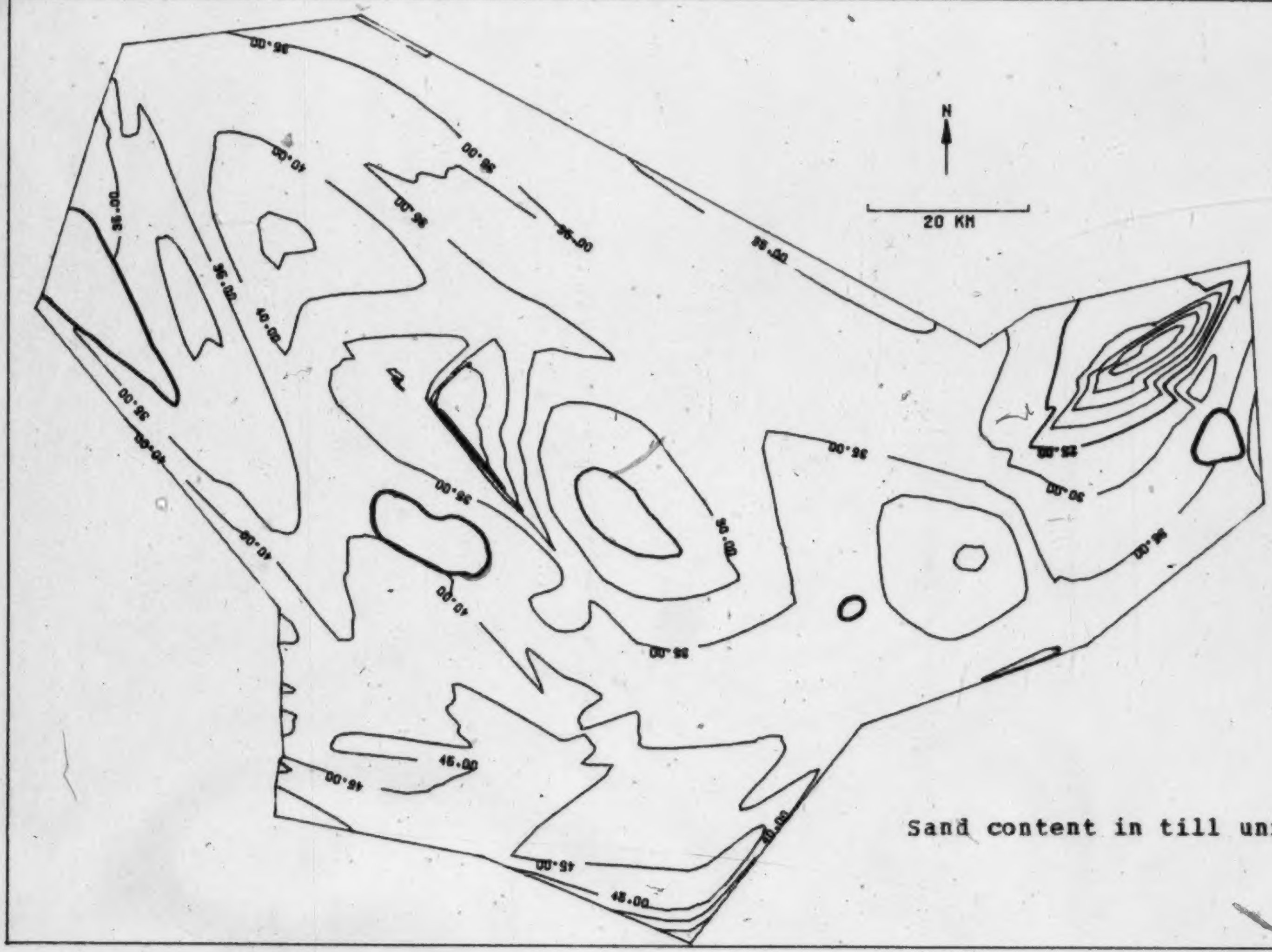
FACTOR SCORE COEFFICIENTS

                FACTOR  1   FACTOR  2   FACTOR  3   FACTOR  4   FACTOR  5   FACTOR  6   FACTOR  7

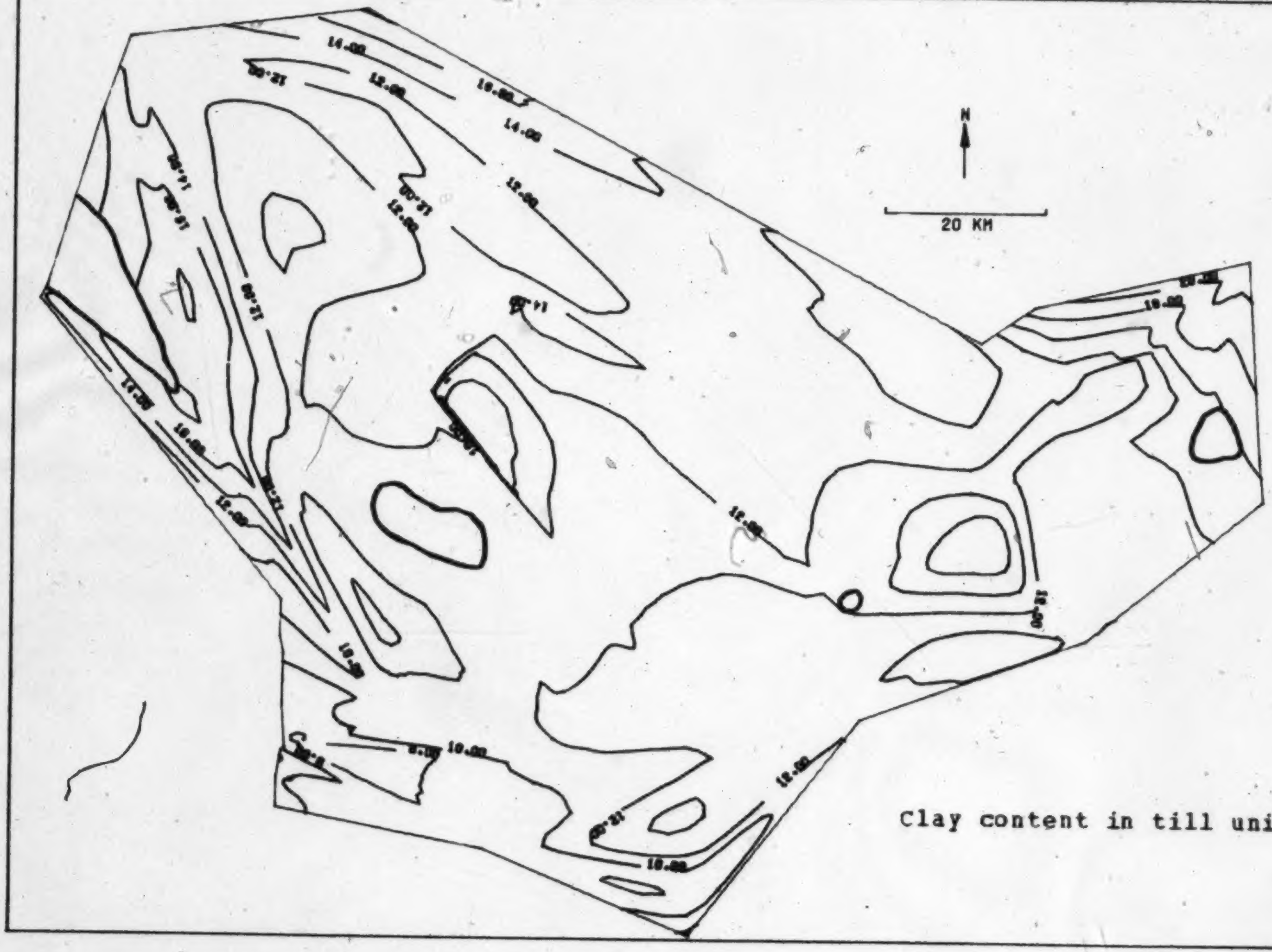
S1020            0.29714     0.08414     0.05125    -0.10112     0.07377    -0.23322    -0.12879
S2043            0.28576    -0.01331     0.03789    -0.05002     0.07610    -0.18584    -0.09520
S4060            0.27844    -0.08017     0.02105     0.04643    -0.05889    -0.17654    -0.04624
S60140           0.03628    -0.00724    -0.02801     0.12847     0.00072     0.32946    -0.01499
S140230         -0.12243     0.88212     0.04603    -0.13239    -0.06638     0.60792    -0.04516
SAND             0.19354    -0.00181     0.01970     0.01952    -0.00627     0.15859    -0.05721
SILT            -0.19652     0.00649    -0.11053    -0.00913     0.15814    -0.17359     0.01745
CLAY            -0.02074    -0.00978     0.19295    -0.04218    -0.31547     0.01016     0.09521
LOCAL            0.06011     0.00171    -0.00213    -0.07630    -0.11625     0.03919    -0.68258
ACID             0.01735     0.00151    -0.01319    -0.03908    -0.32344    -0.11208     0.30784
BASIC           -0.06797     0.08637    -0.00964    -0.17237     0.10252     0.07605     0.19311
CARB             0.03159     0.07808     0.06168    -0.16365     0.48182    -0.15267     0.11911
QTZ             -0.08329    -0.15772    -0.00151     0.26613     0.29919     0.14142     0.17501
CACO3           -0.01563     0.22587    -0.07834    -0.07919     0.06798    -0.02942     0.04737
NA              -0.06062     0.00448    -0.07462     0.40430     0.04583     0.07450    -0.01349
MG              -0.04450     0.26899    -0.00482     0.00117    -0.00114     0.06818    -0.03742
AL               0.06070    -0.00095     0.38952     0.11195    -0.10181    -0.00556    -0.05336
SI               0.00031    -0.29708    -0.25504    -0.10818    -0.01014    -0.07423     0.05566
K                0.06358    -0.06147     0.04356     0.49220    -0.13058    -0.15918    -0.03469
CA              -0.02968     0.28253    -0.00436    -0.05620     0.05535     0.08896    -0.03067
TI               0.08825     0.01558     0.23407    -0.21021     0.21834    -0.02161     0.07028
FE               0.04818     0.05952     0.41668    -0.04701     0.05177     0.09319    -0.02616
```

APPENDIX 7

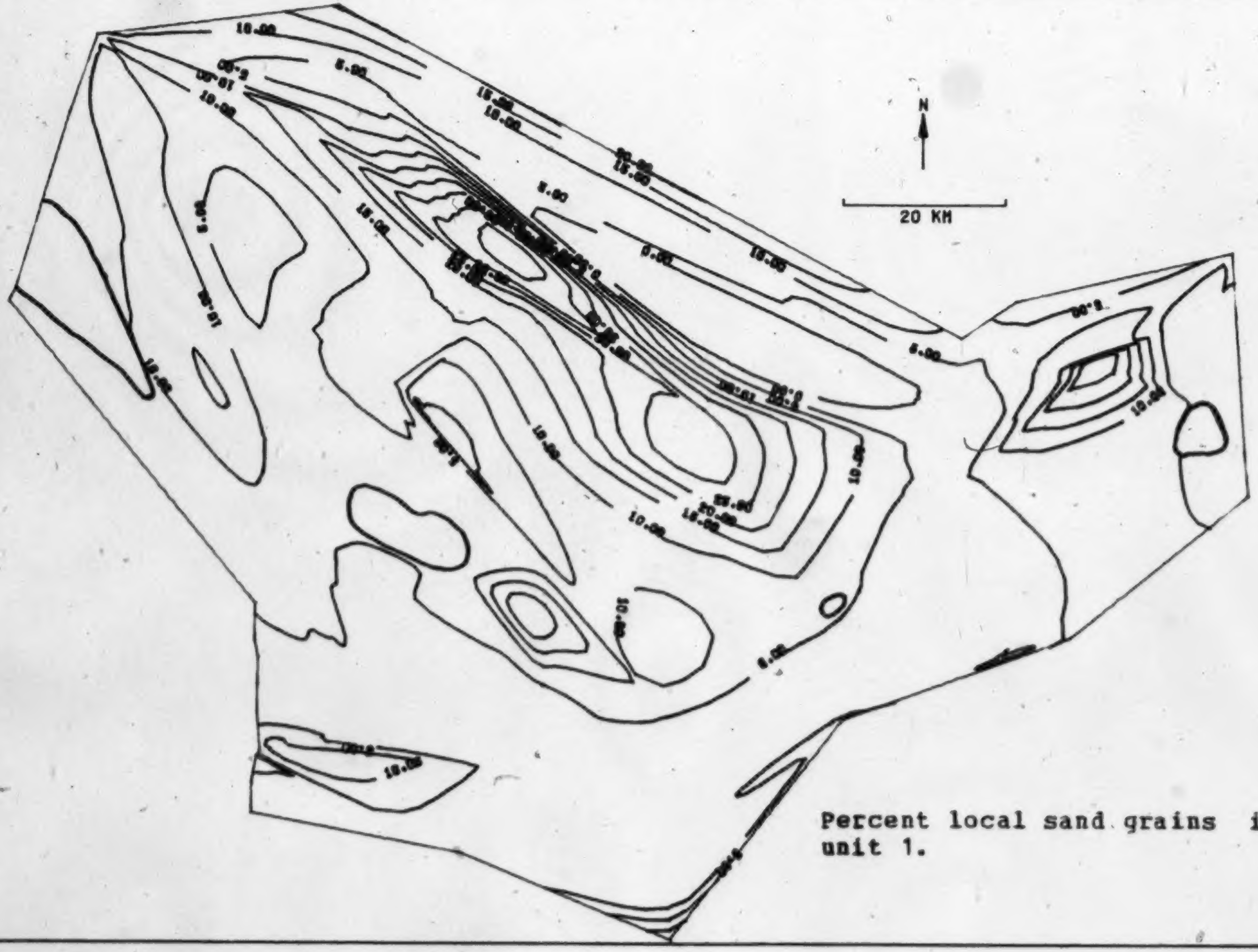
Contour maps showing the lateral variation of sand, clay, grain lithology, calcium carbonate equivalent and bulk chemistry in each of the four till units. A heavy black line marks any till unit boundaries.


N
20 KM
35.00
40.00
35.00
35.00
35.00
35.00
35.00
40.00
35.00
35.00
40.00
40.00
30.00
35.00
40.00
35.00
25.00
30.00
35.00
45.00
45.00
45.00
45.00
40.00

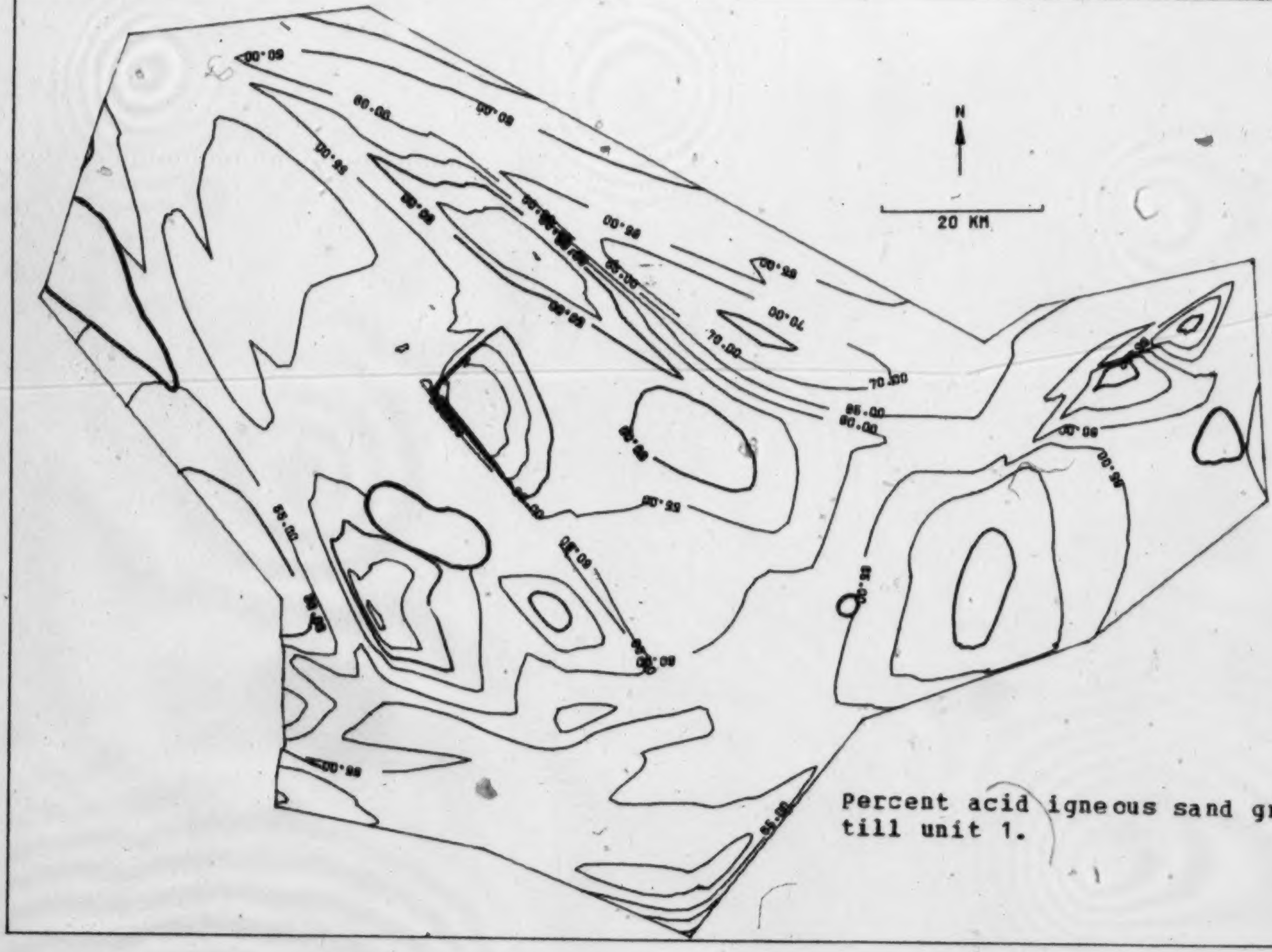
Sand content in till unit 1.


N
20 KM
14.00
12.00
10.00
16.00
8.00

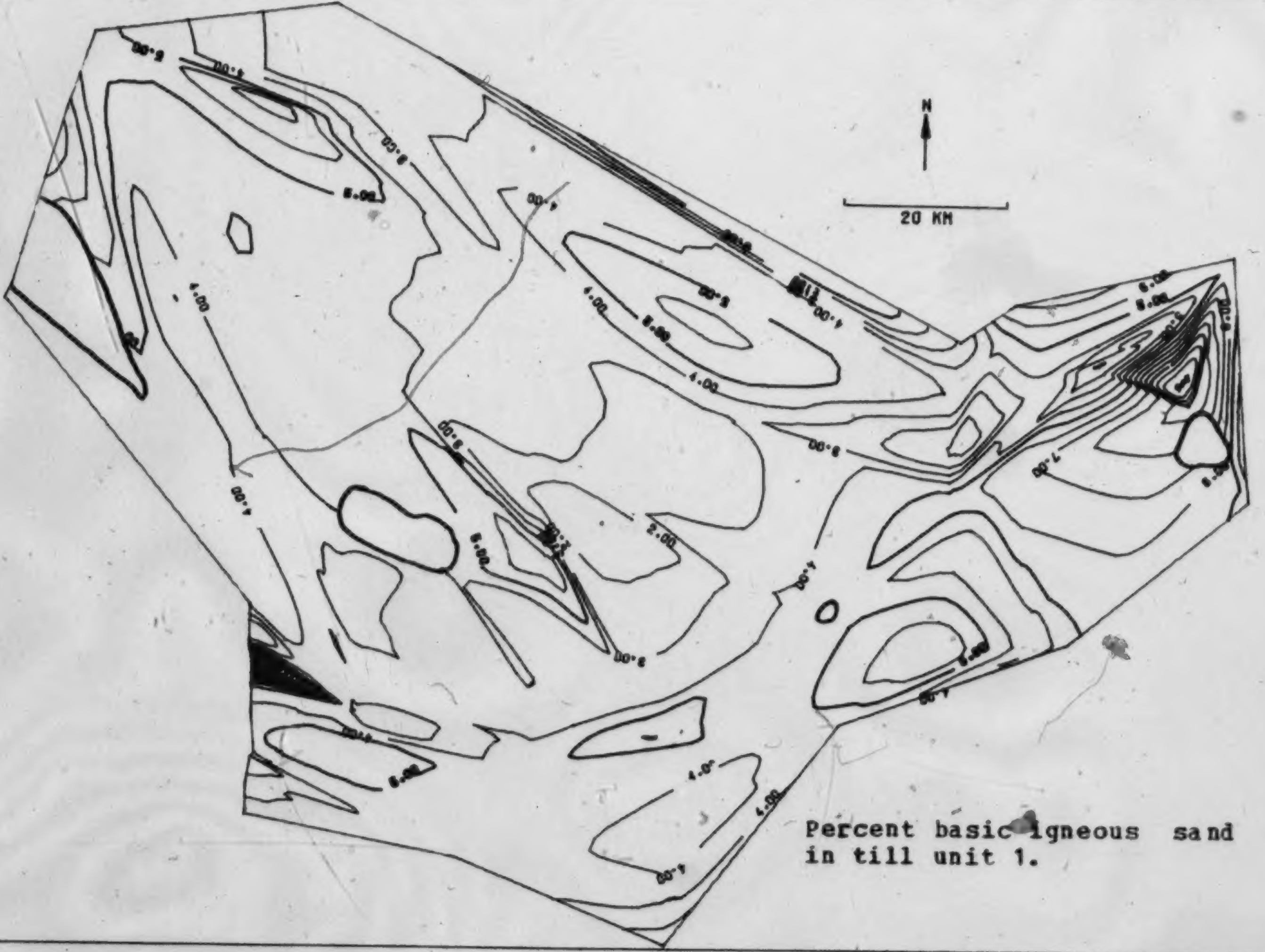
Clay content in till unit 1.


N
20 KM
5.00
10.00
15.00
20.00
25.00

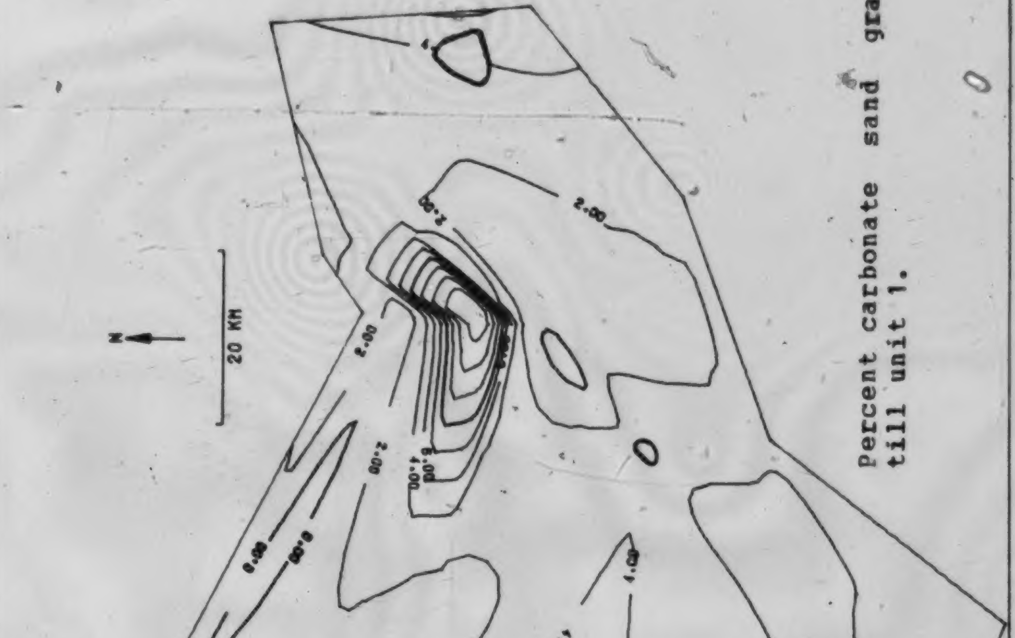
Percent local sand grains in till unit 1.


N
20 KM
60.00
80.00
85.00
70.00
65.00
55.00

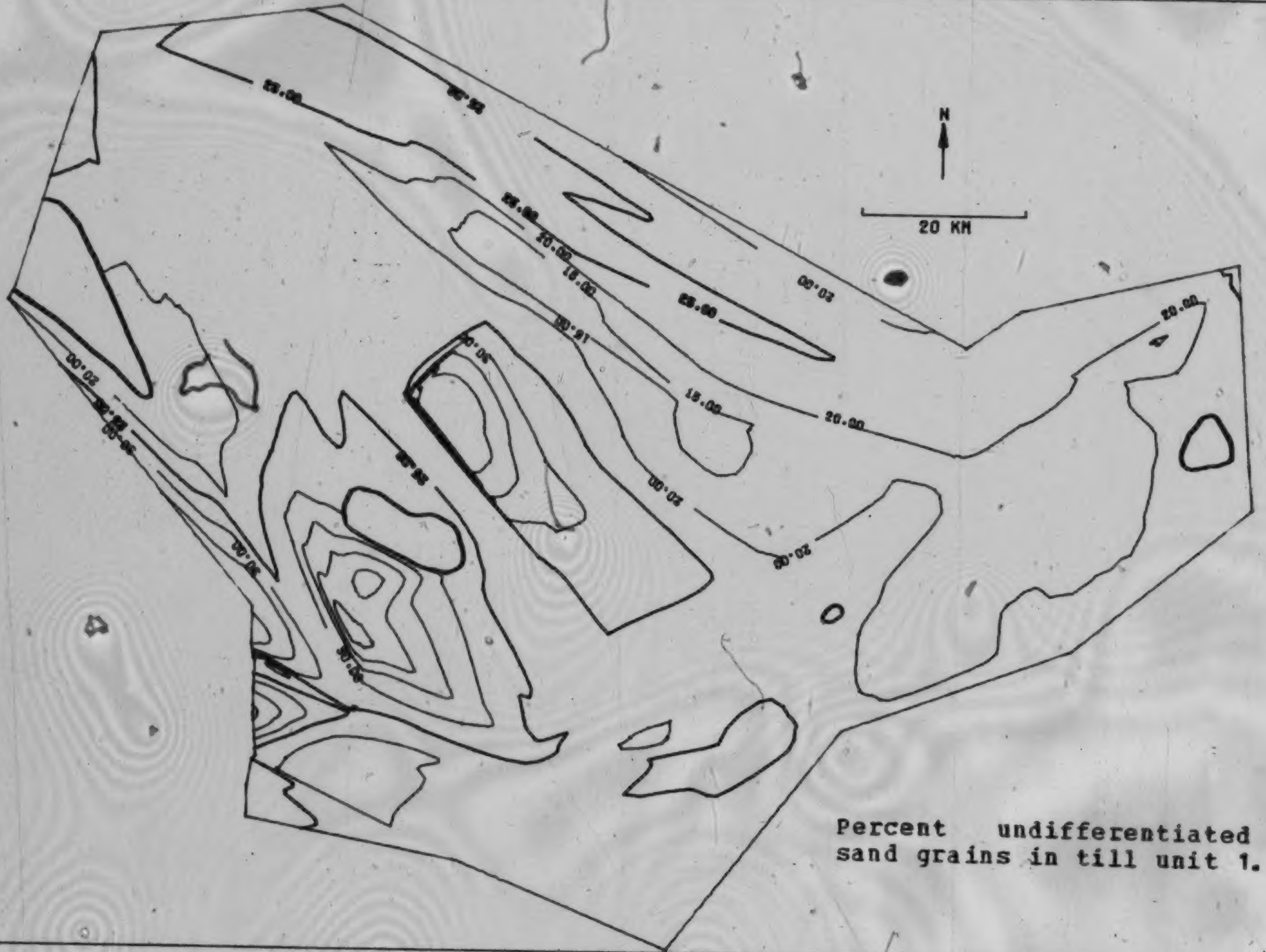
Percent acid igneous sand grains in till unit 1.


N
20 KM
2.00
4.00
6.00
7.00
8.00

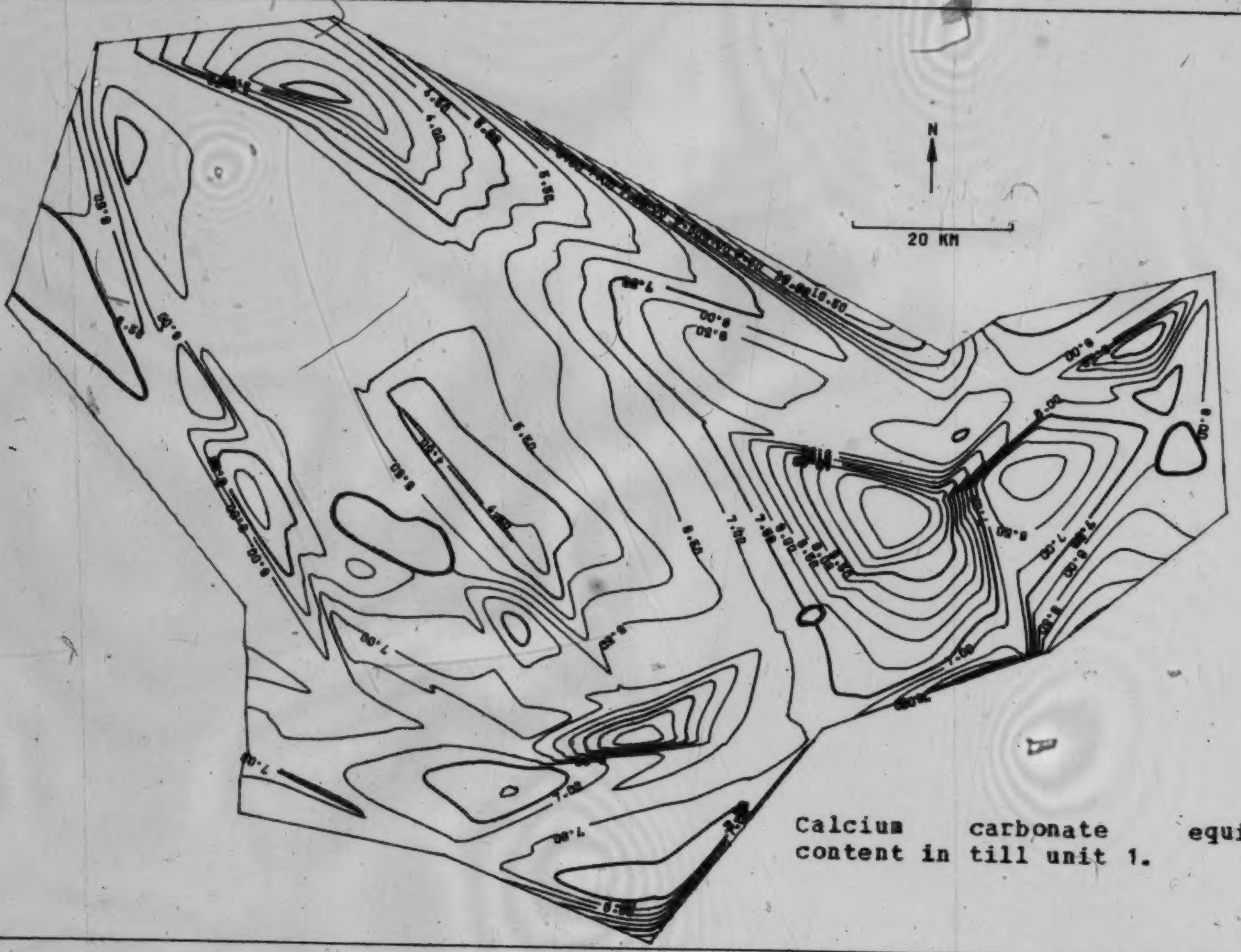
Percent basic igneous sand grains
in till unit 1.


N
20 KM
2.00
4.00
6.00
8.00

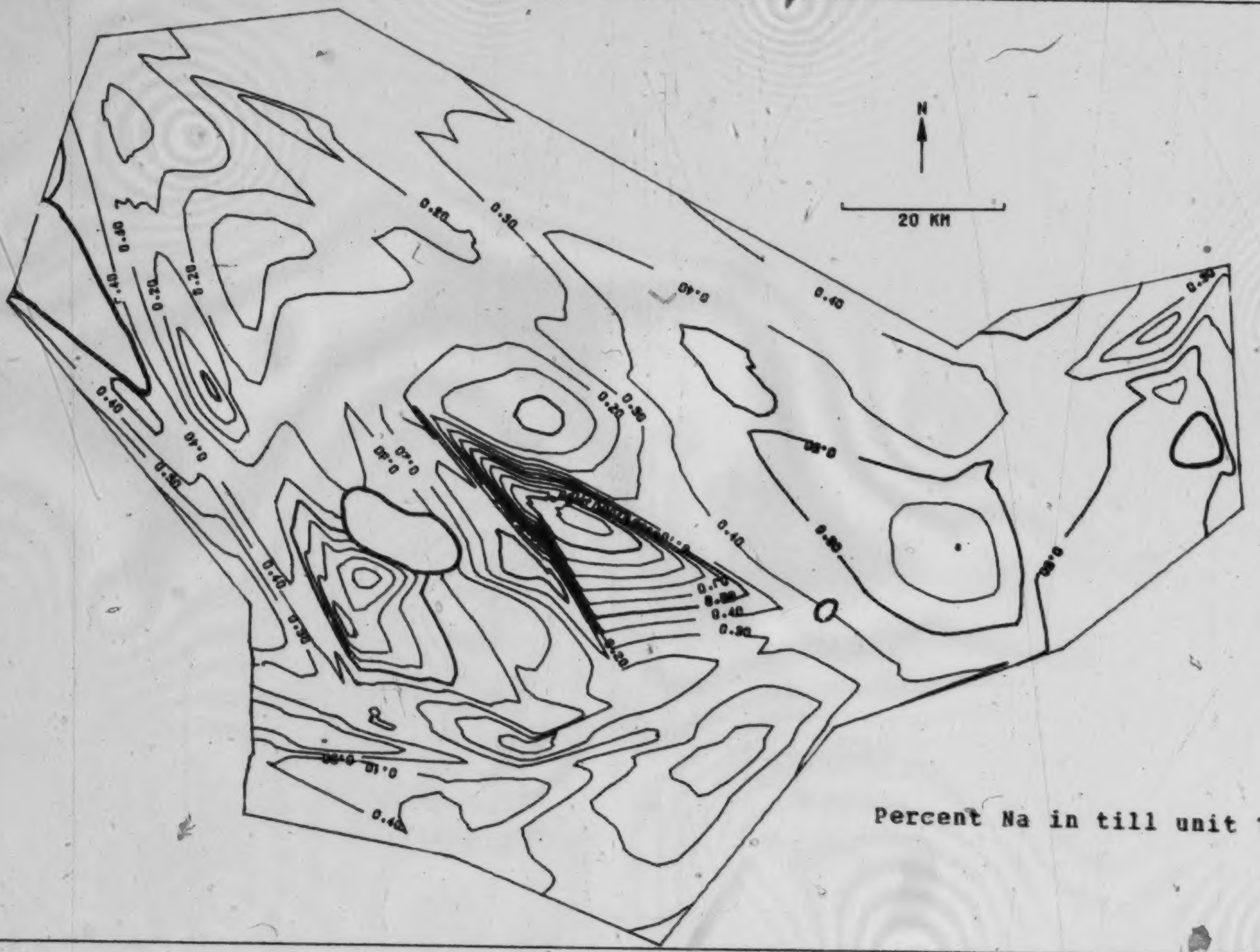
Percent carbonate sand grains in till unit 1.


N
20 KM
25.00
25.00
25.00
25.00
20.00
20.00
20.00
20.00
20.00
20.00
15.00
15.00
15.00
30.00
30.00
30.00
30.00

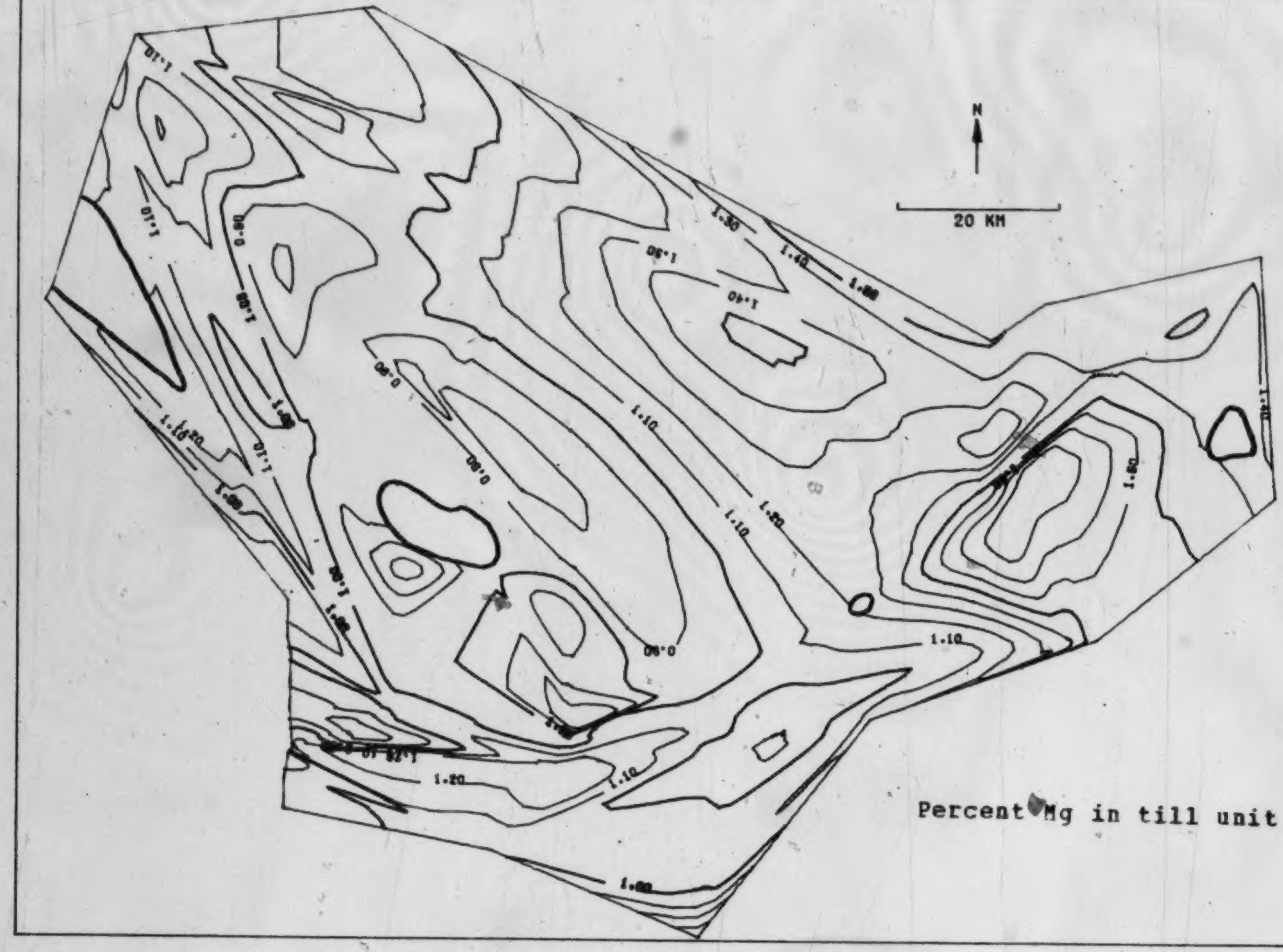
Percent undifferentiated quartz sand grains in till unit 1.


N
20 KM
6.00
6.50
7.00
7.50
8.00
10.50

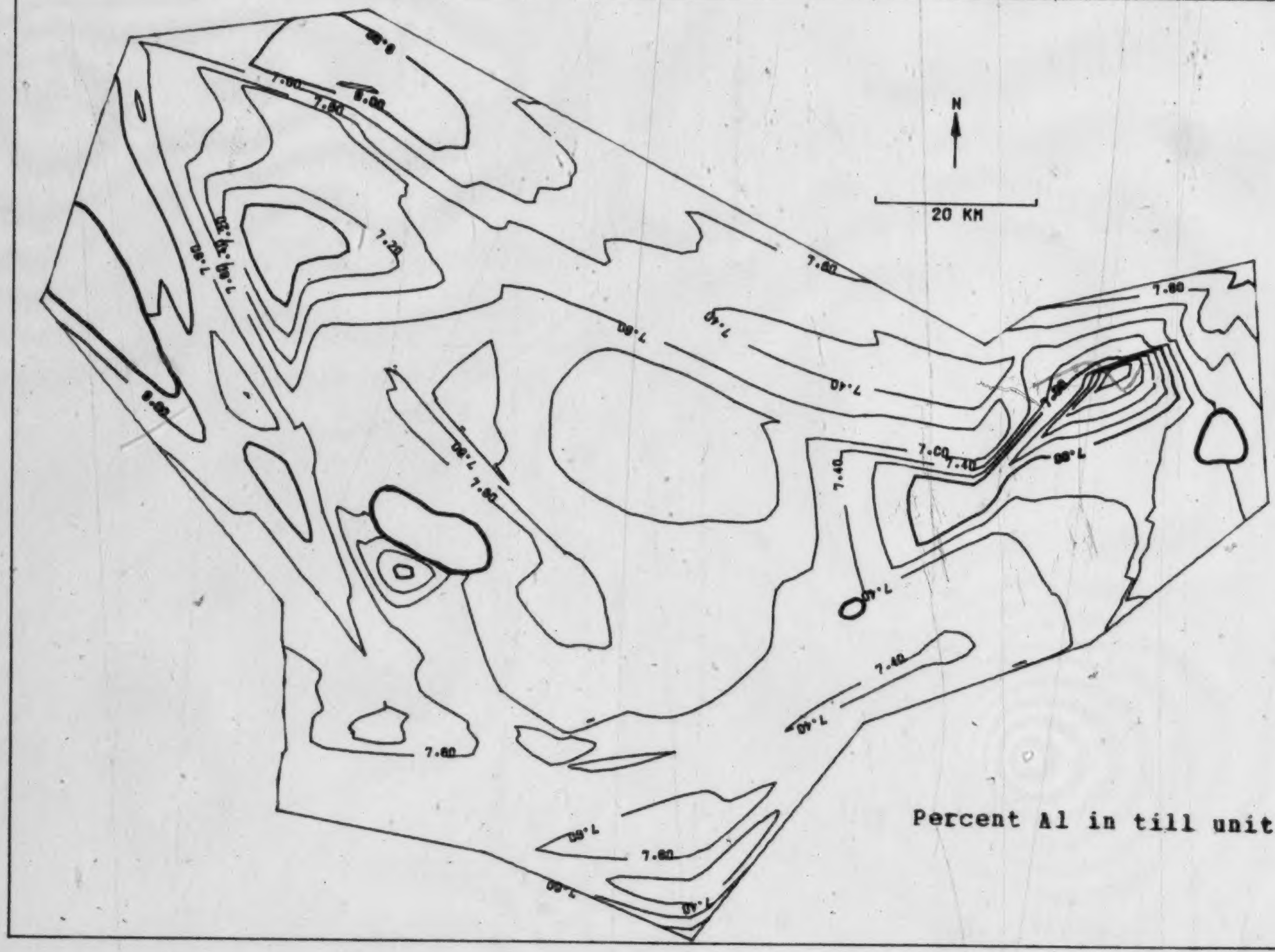
Calcium carbonate equivalent content in till unit 1.


N
20 KM
0.20
0.30
0.40
0.10

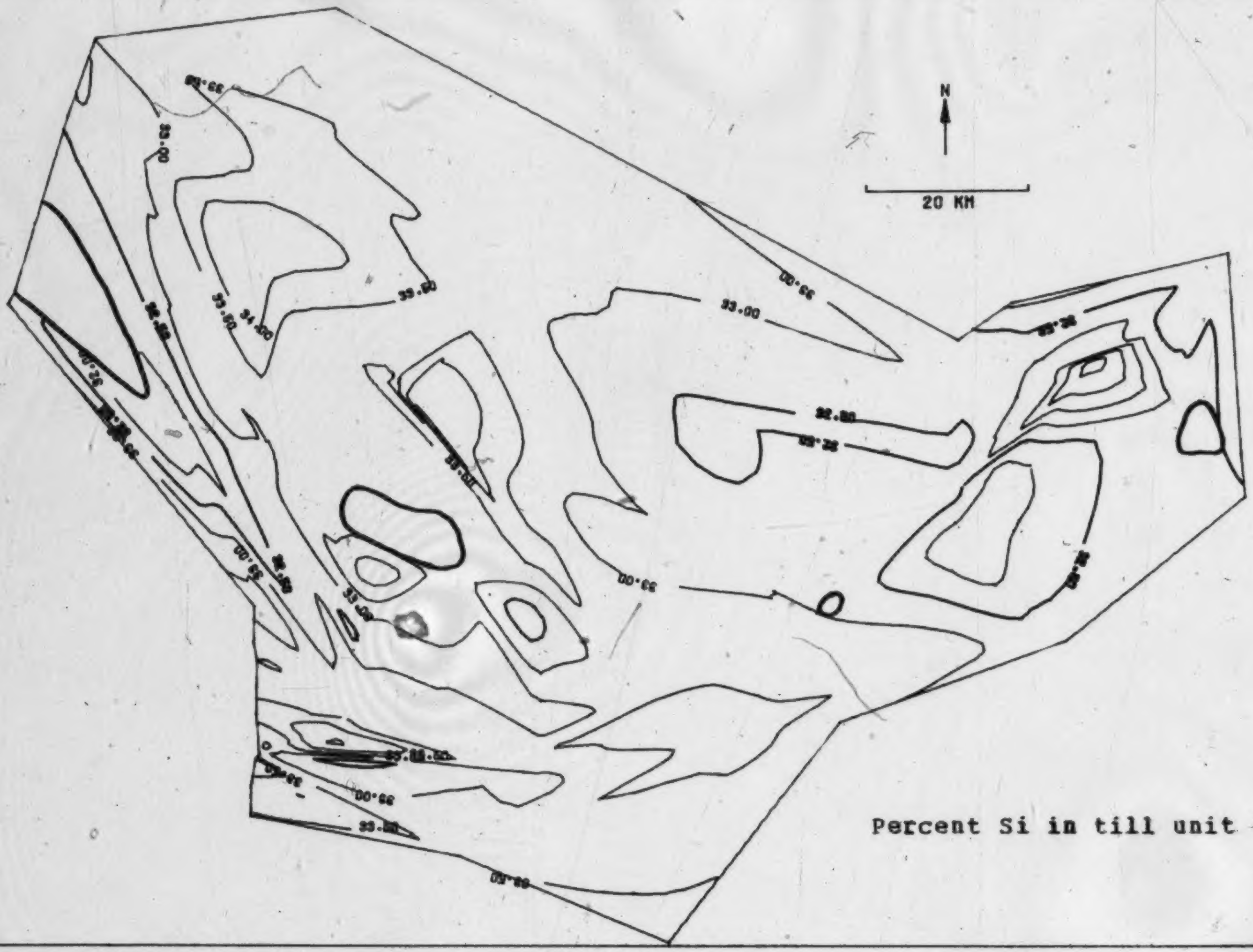
Percent Na in till unit 1.


N
20 KM
1.30
1.40
1.50
1.10
1.20
0.90
1.60

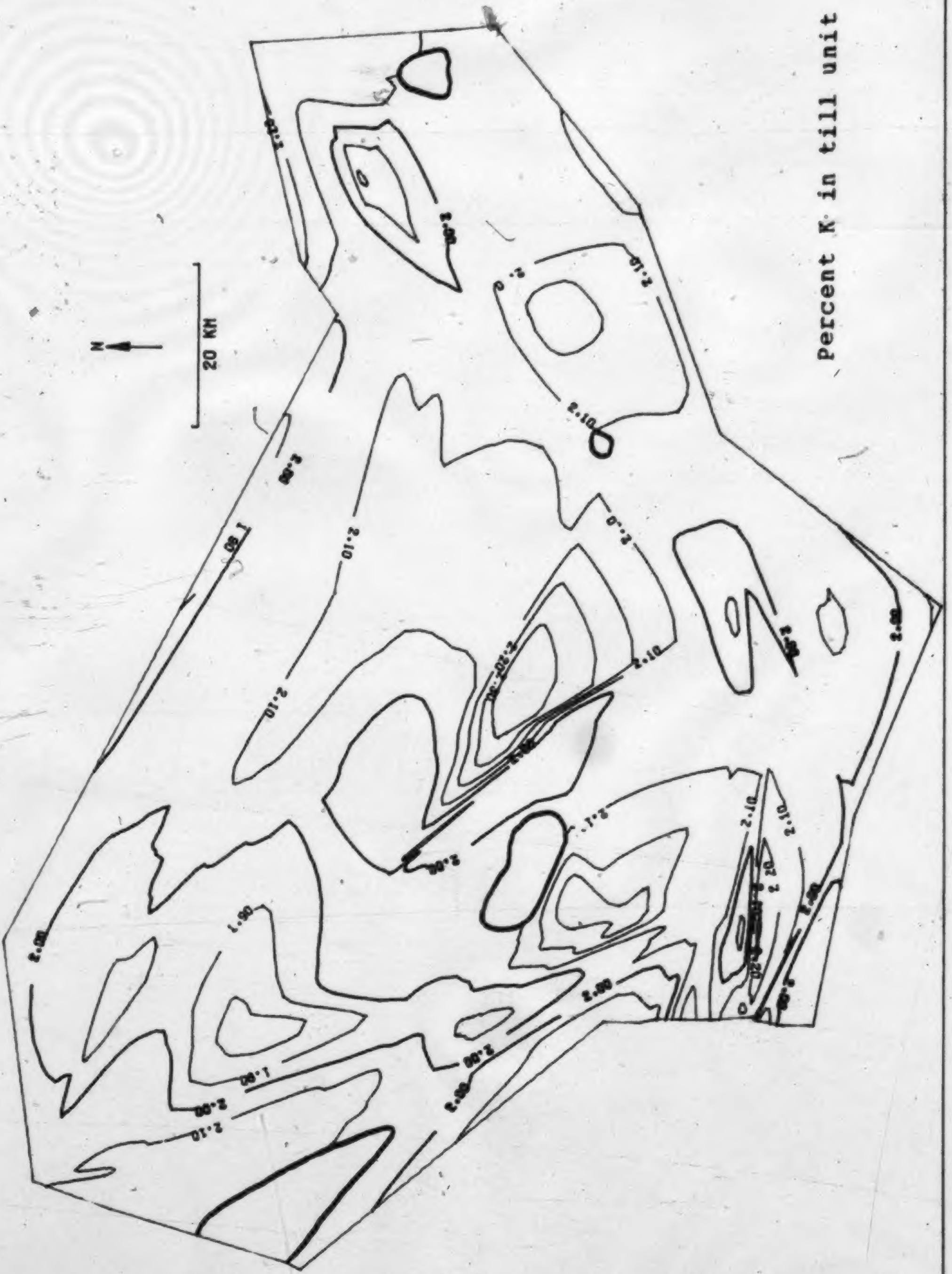
Percent Mg in till unit 1.


N
20 KM
7.00
7.20
7.40
7.60
7.80
8.00

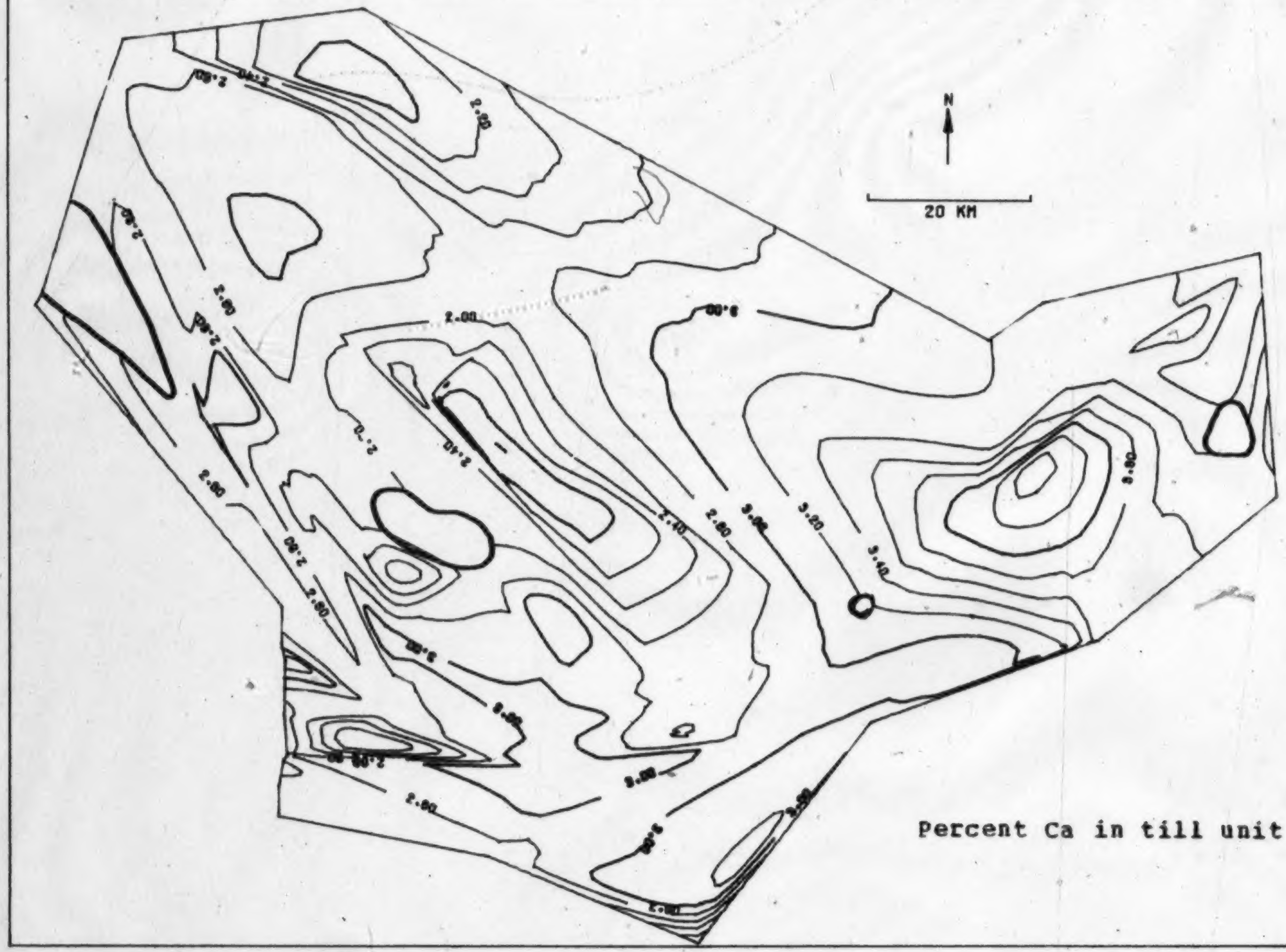
Percent Al in till unit 1.


N
20 KM
33.00
33.50
34.00
32.50
32.00

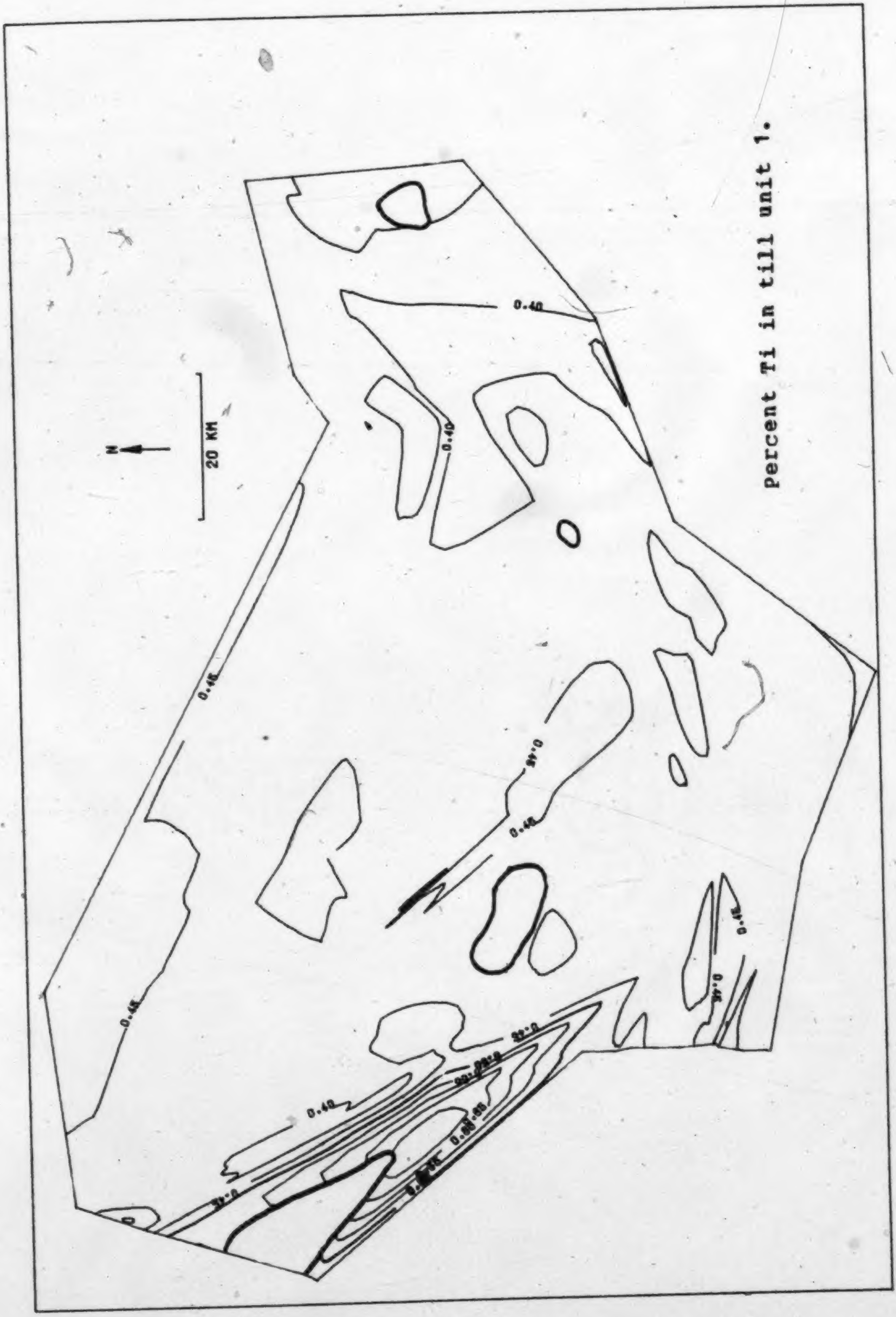
Percent Si in till unit 1.


N
20 KM
2.10
2.00
1.90
1.80
2.20

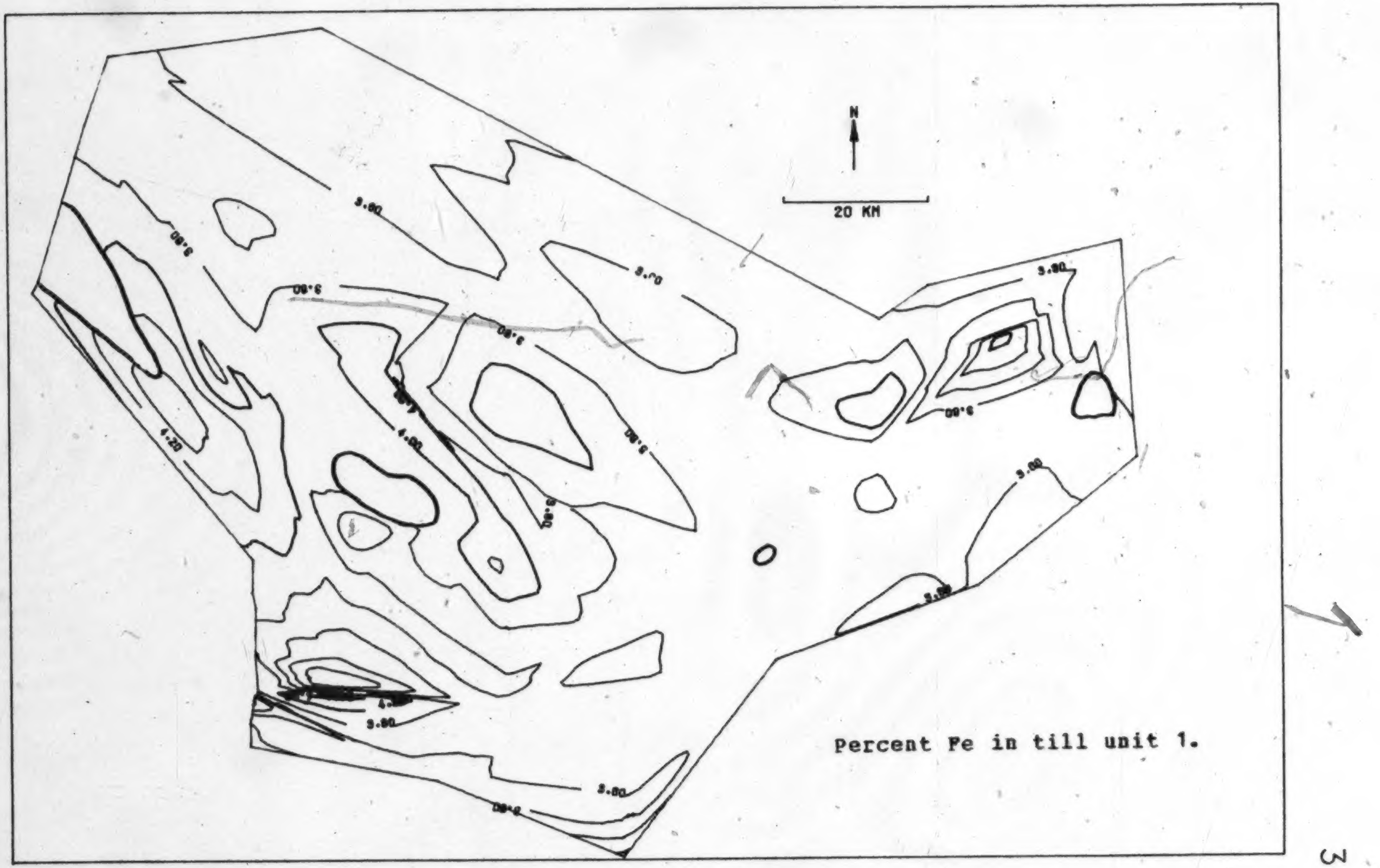
Percent K in till unit 1.


N
20 KM
2.00
2.20
2.40
2.60
2.80
3.00
3.20
3.40
3.80

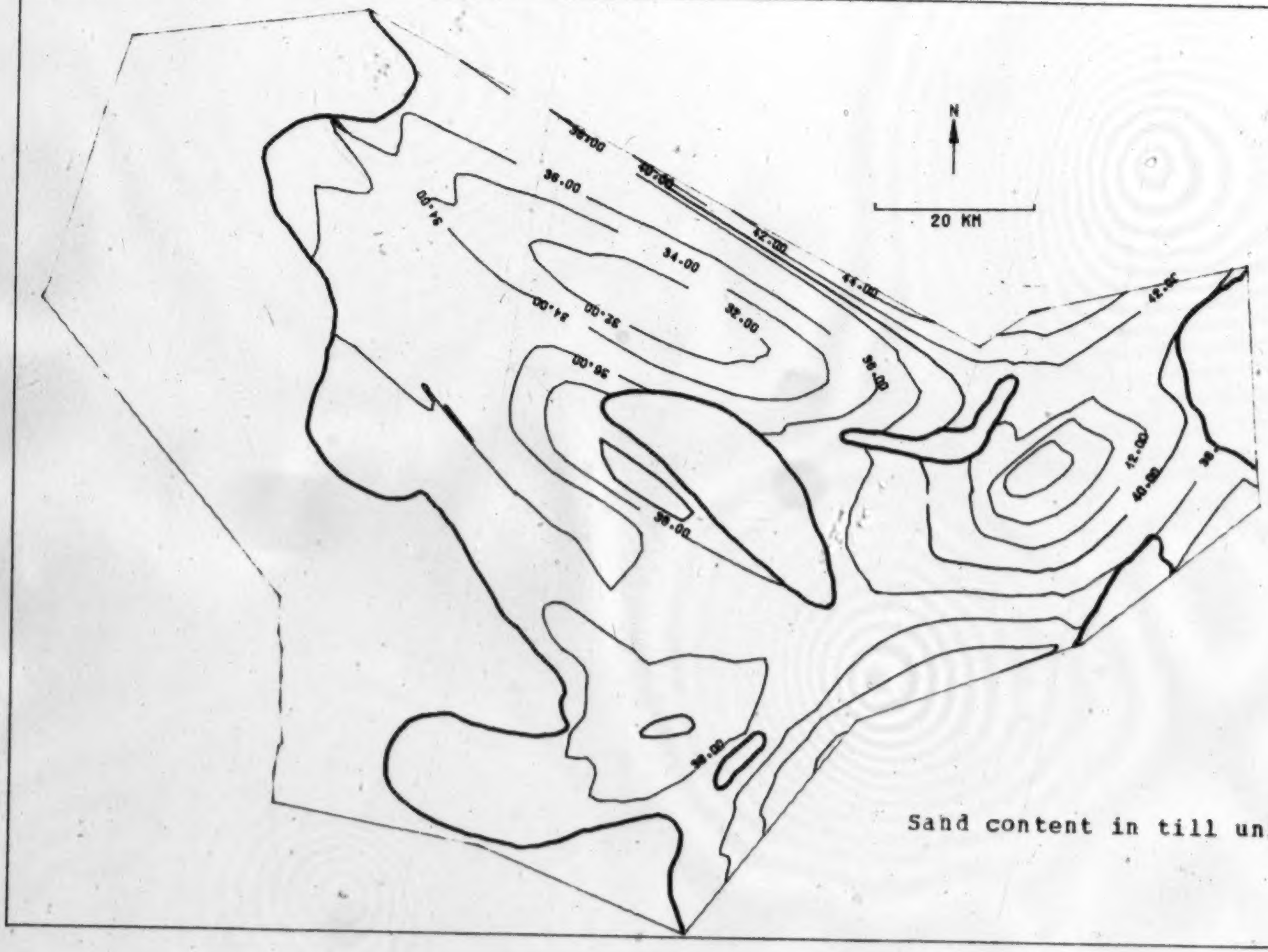
Percent Ca in till unit 1.


N
20 KM
0.40
0.45

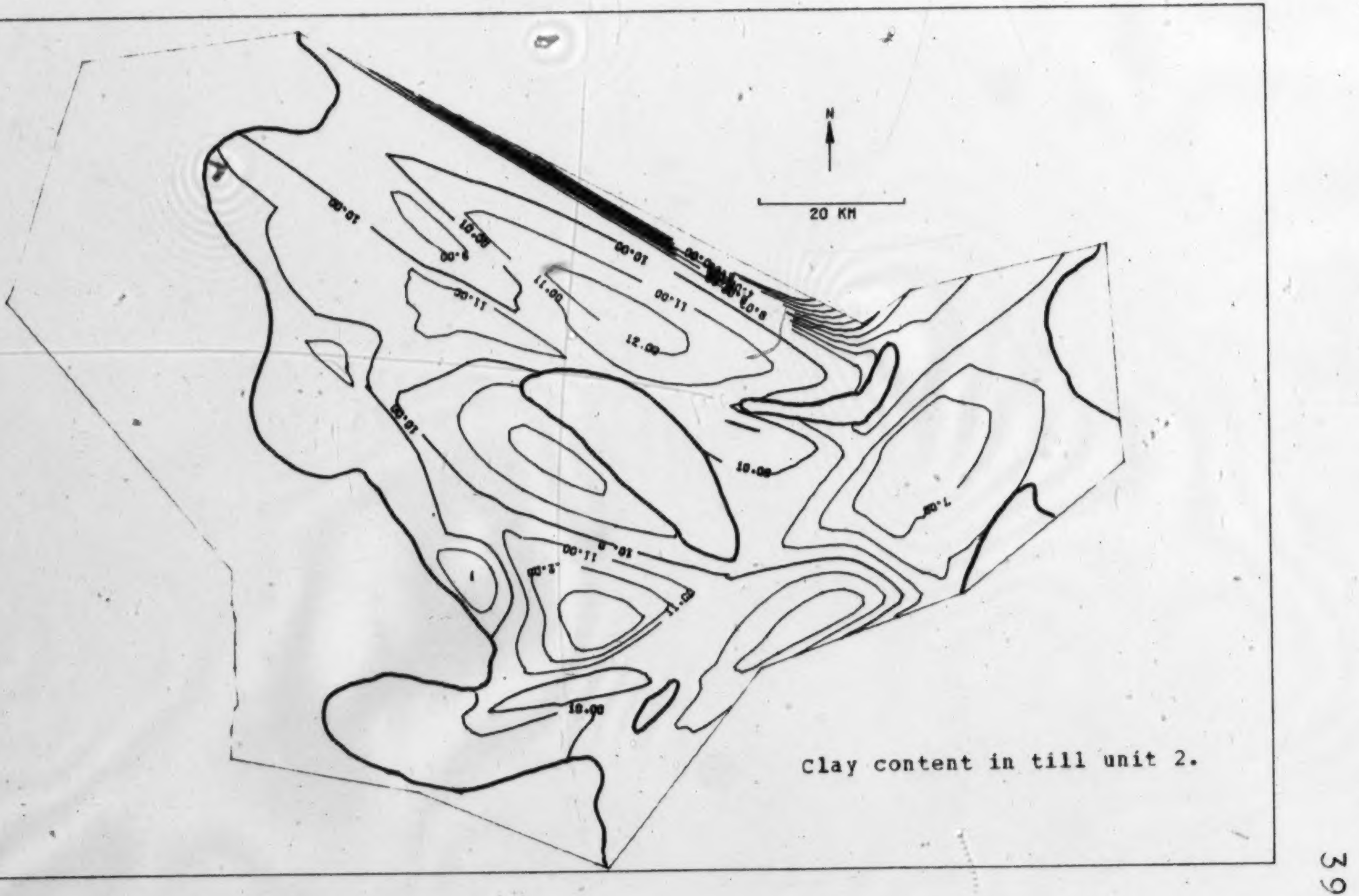
Percent Ti in till unit 1.


N
20 KM
3.80
3.60
3.60
3.70
3.80
3.60
4.20
4.00
3.80
3.80
3.80
3.60
3.80
3.80
4.20
3.80
3.80
3.60

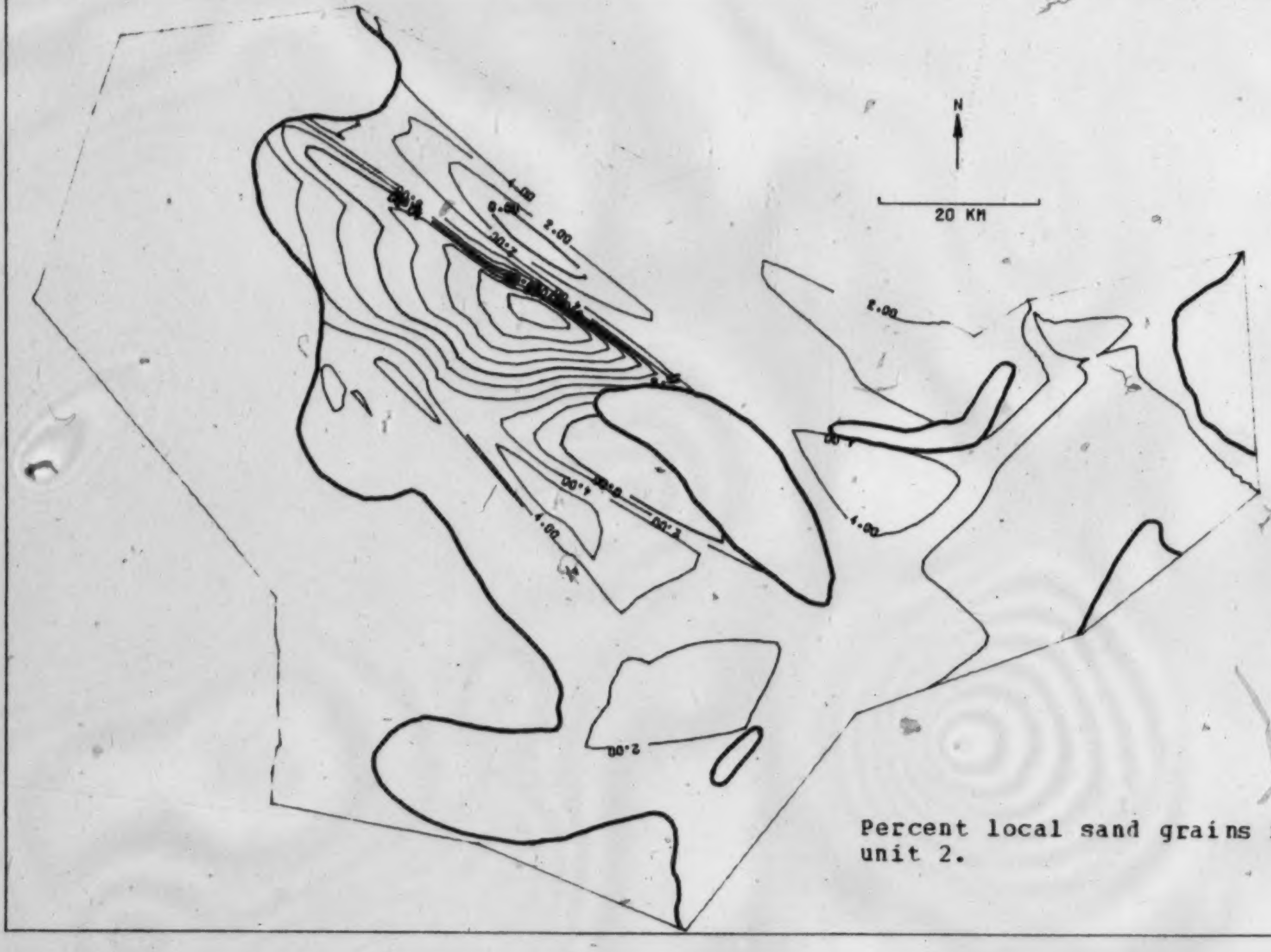
Percent Fe in till unit 1.


N
20 KM
38.00
40.00
42.00
44.00
36.00
34.00
32.00
34.00
32.00
36.00
34.00
36.00
38.00
38.00
42.00
40.00
38
42.00

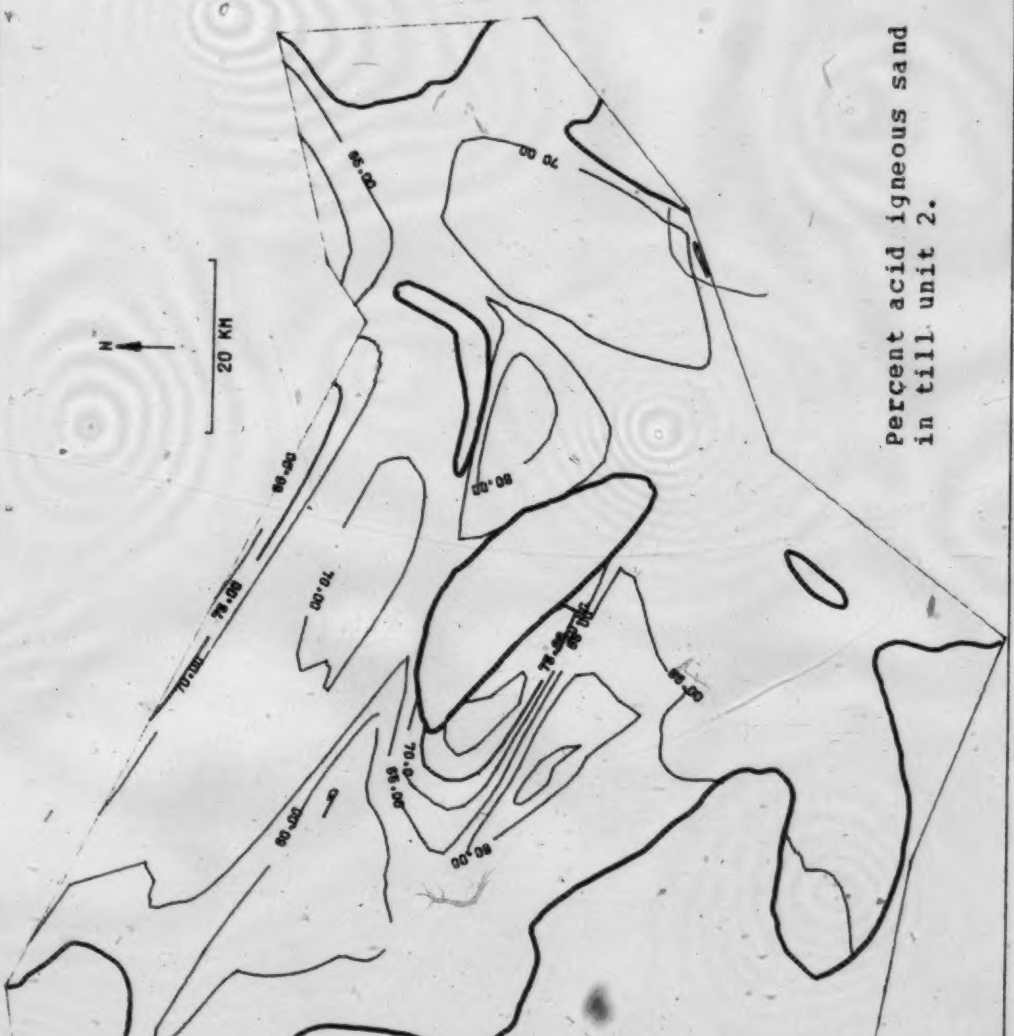
Sand content in till unit 2.


N
20 KM
10.00
10.20
9.00
11.00
12.00
8.00
7.00

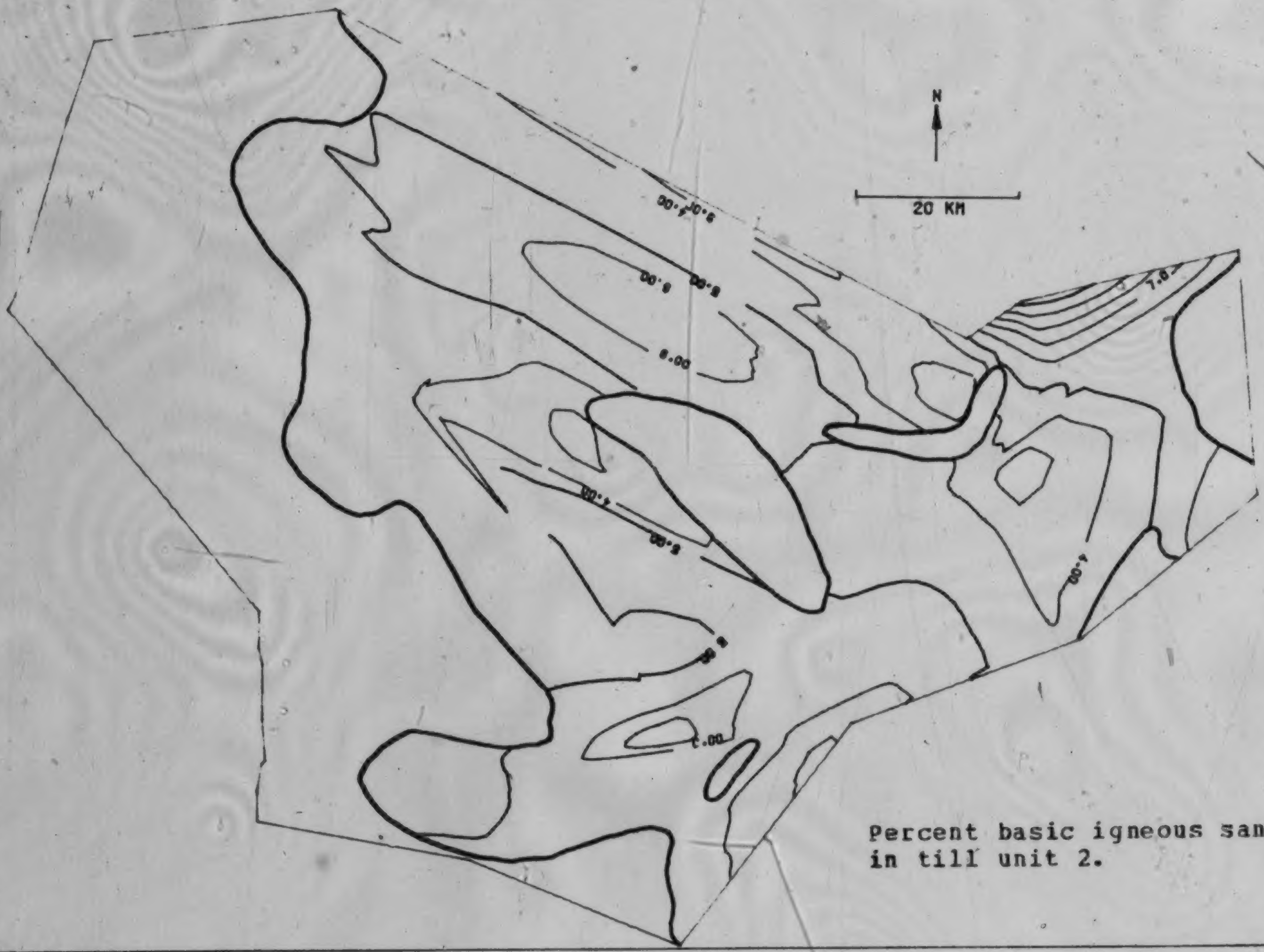
Clay content in till unit 2.


N
20 KM
4.00
2.00
6.00
2.00
4.00
4.00
6.00
4.00
2.00
4.00
2.00

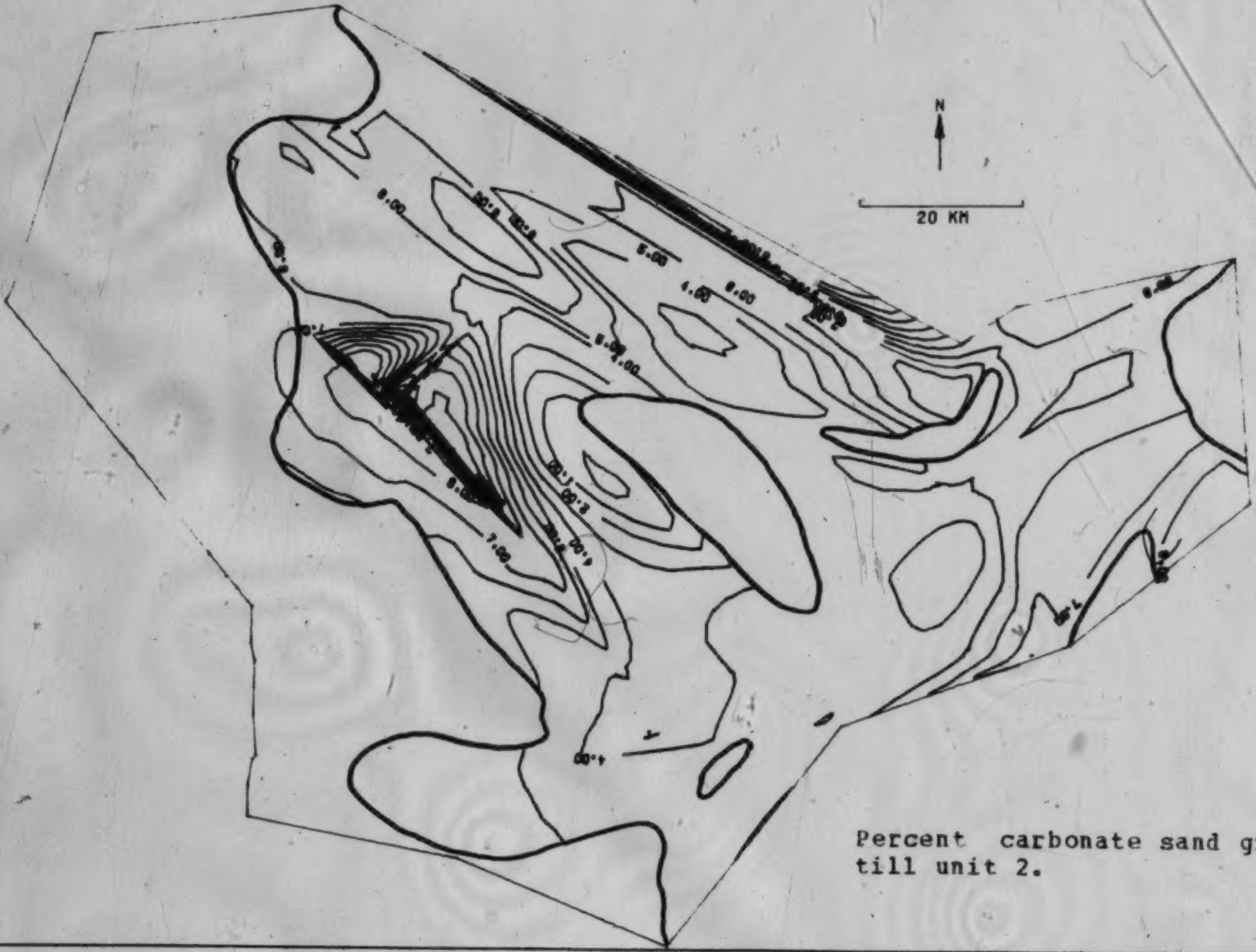
Percent local sand grains in till unit 2.


N
20 KM
70.00
65.00
80.00
75.00

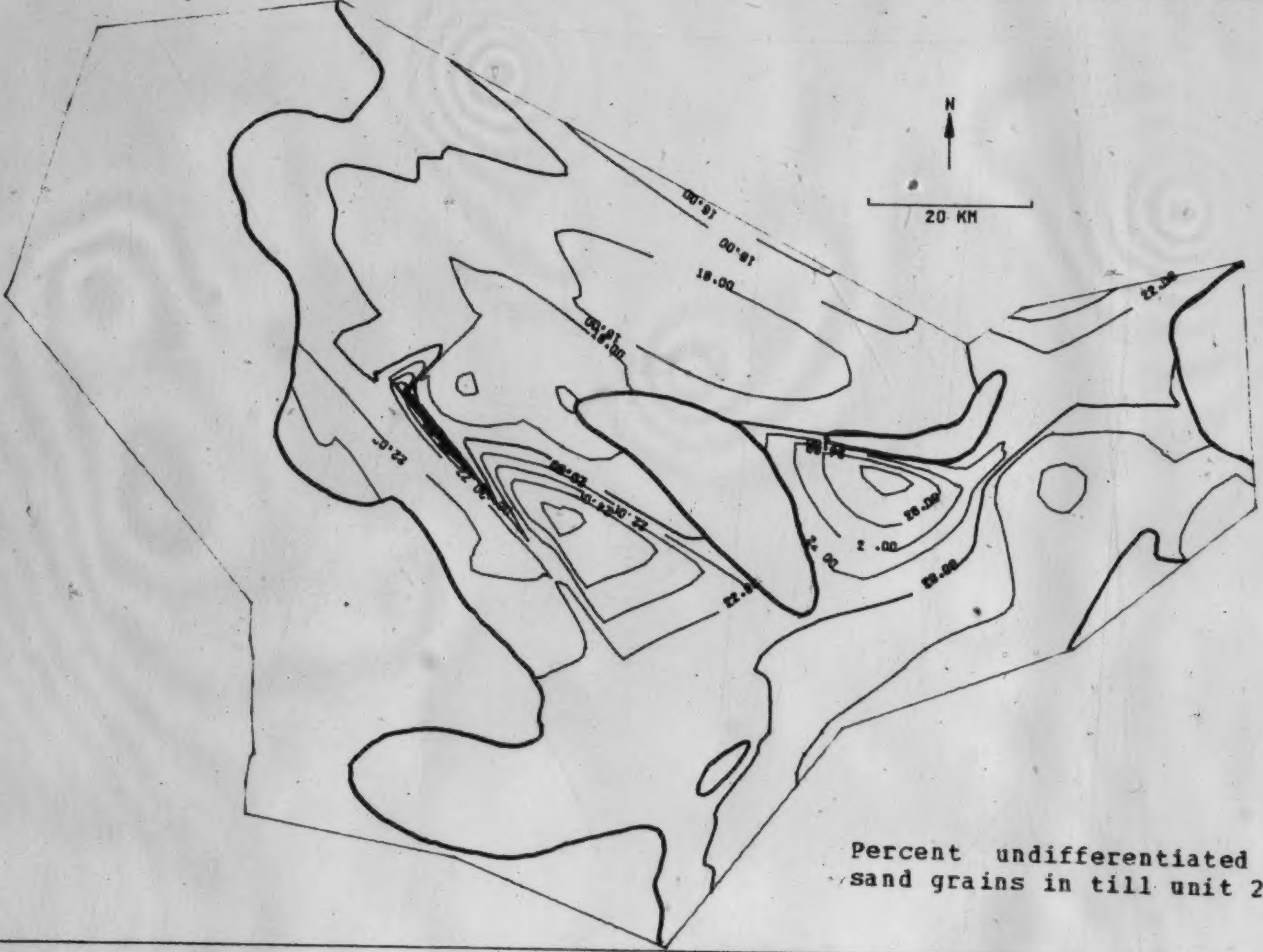
Percent acid igneous sand grains in till unit 2.



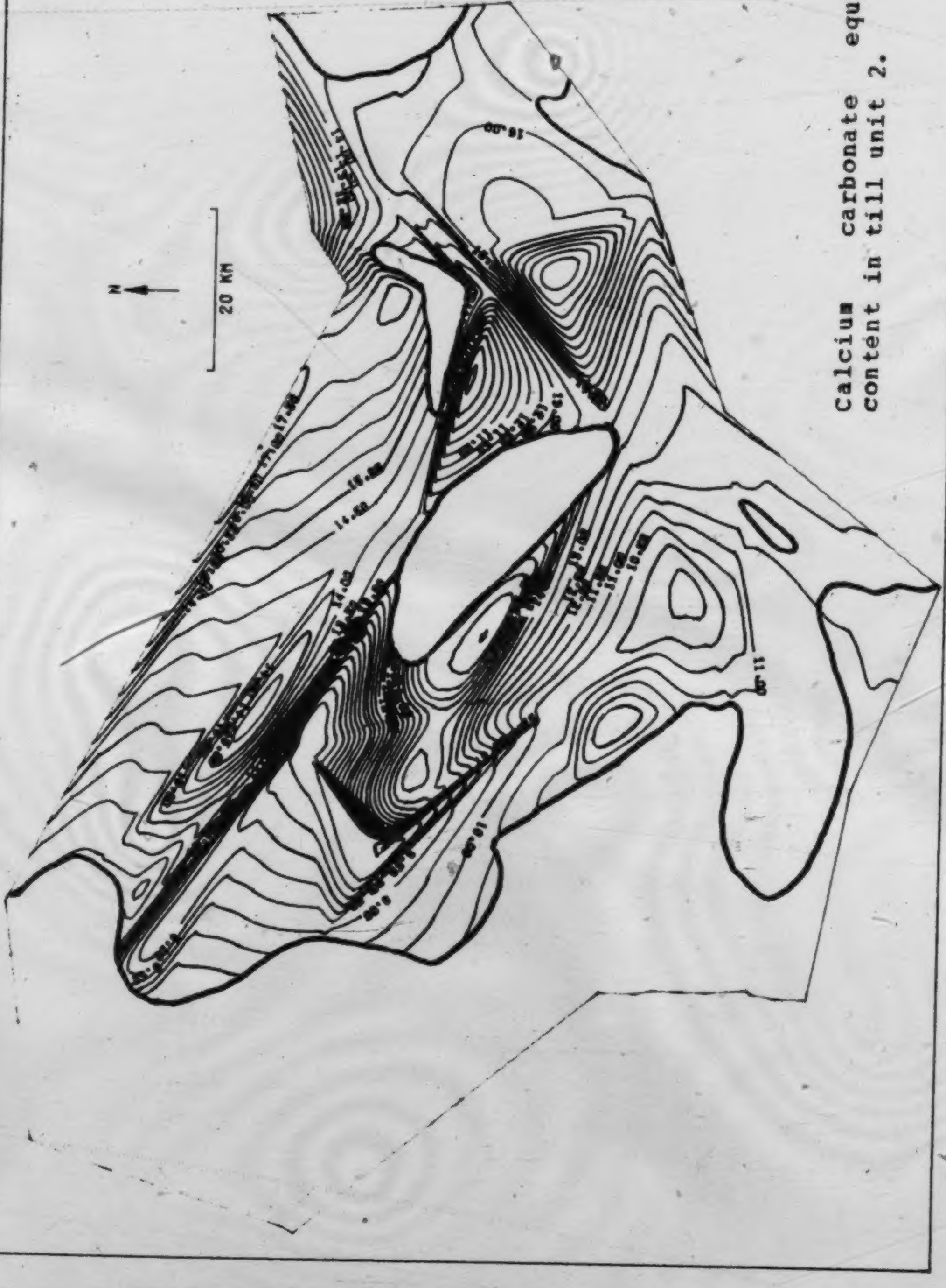
Percent basic igneous sand grains
in till unit 2.


N
20 KM
8.00
4.00
7.00

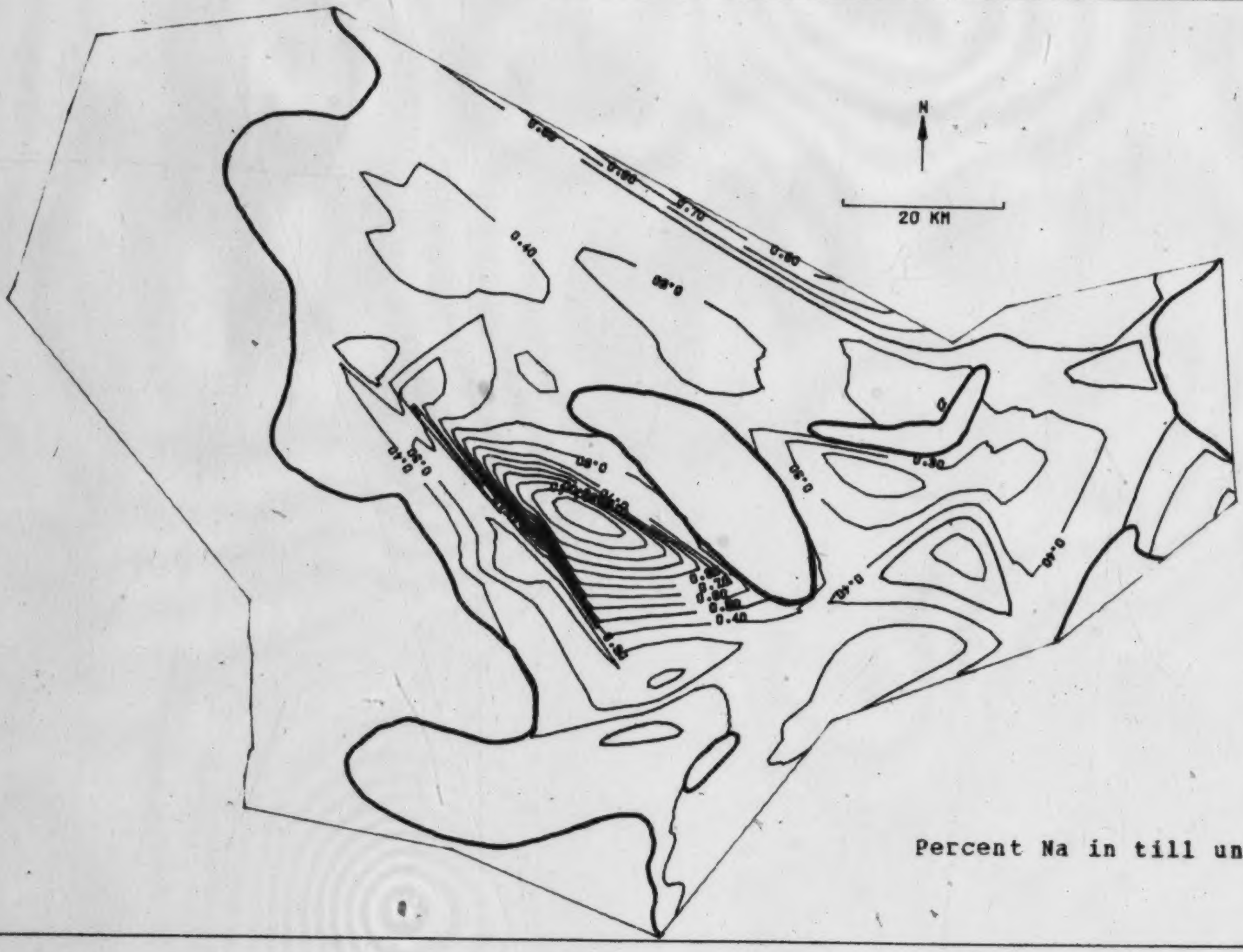
Percent carbonate sand grains in till unit 2.


N
20 KM
18.00
18.00
18.00
22.00
20.00
2.00

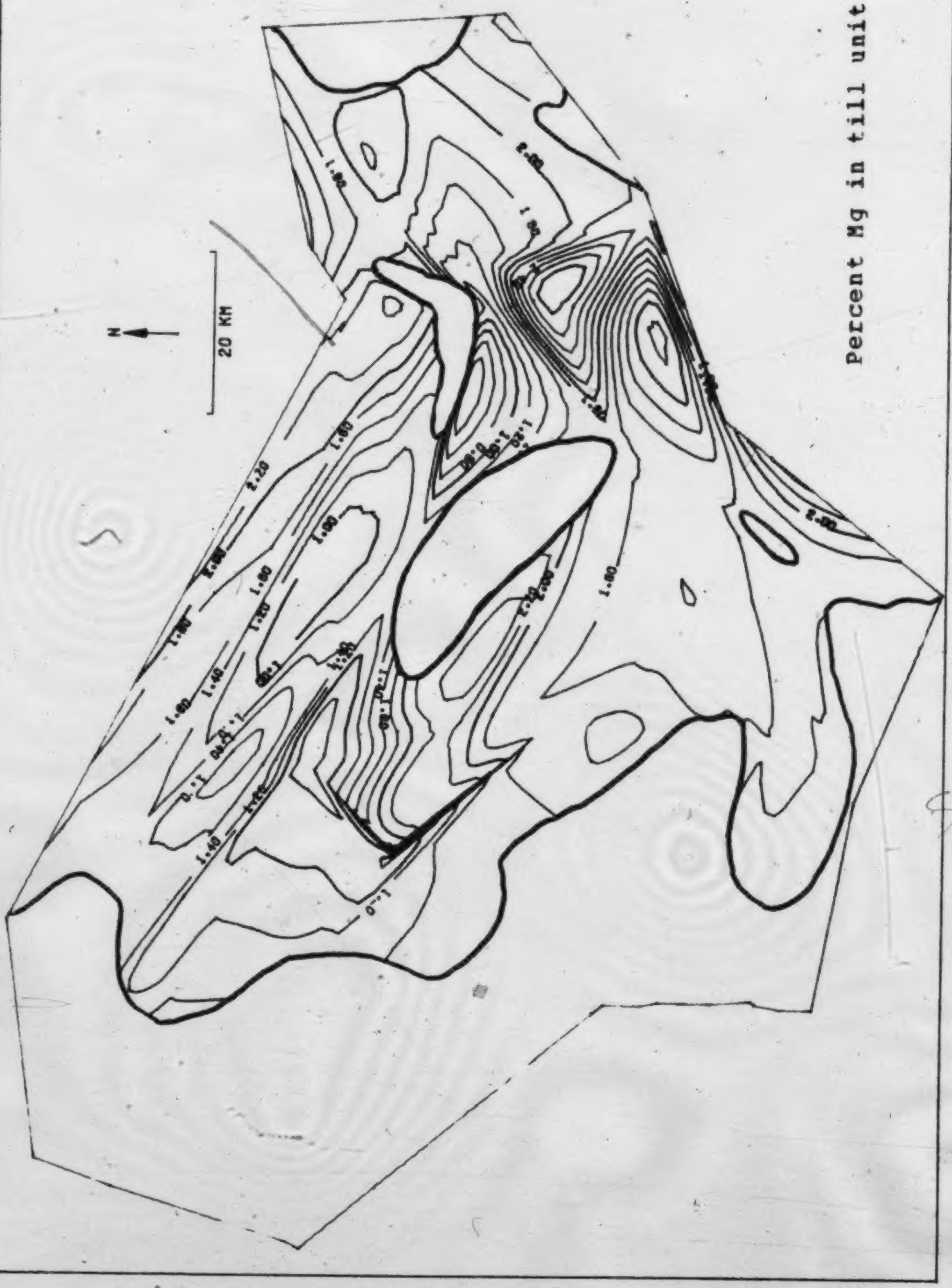
Percent undifferentiated quartz sand grains in till unit 2.


N
20 KM
14.50
15.00
11.00

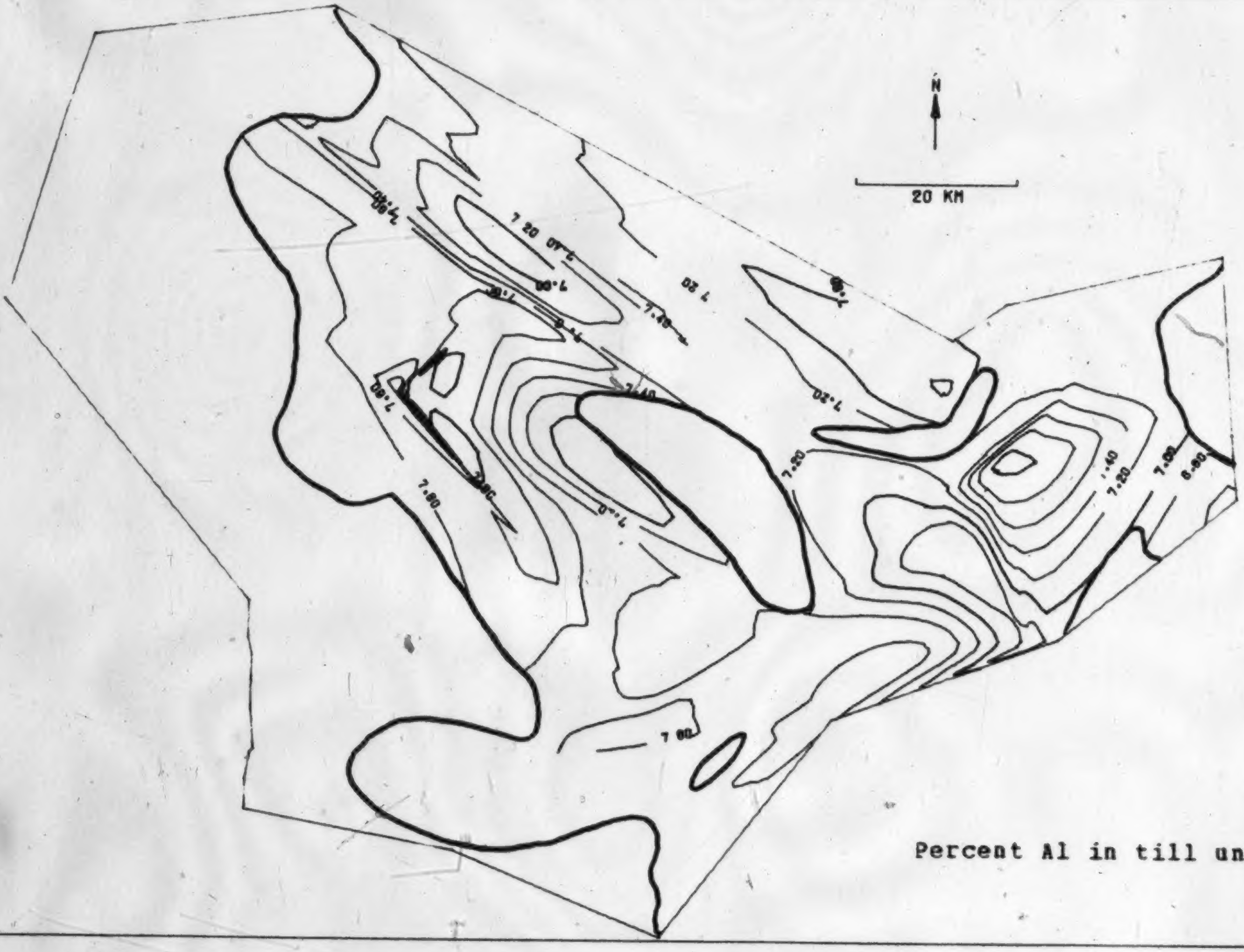
Calcium carbonate equivalent content in till unit 2.


N
20 KM
0.40
0.80
0.70
0.30

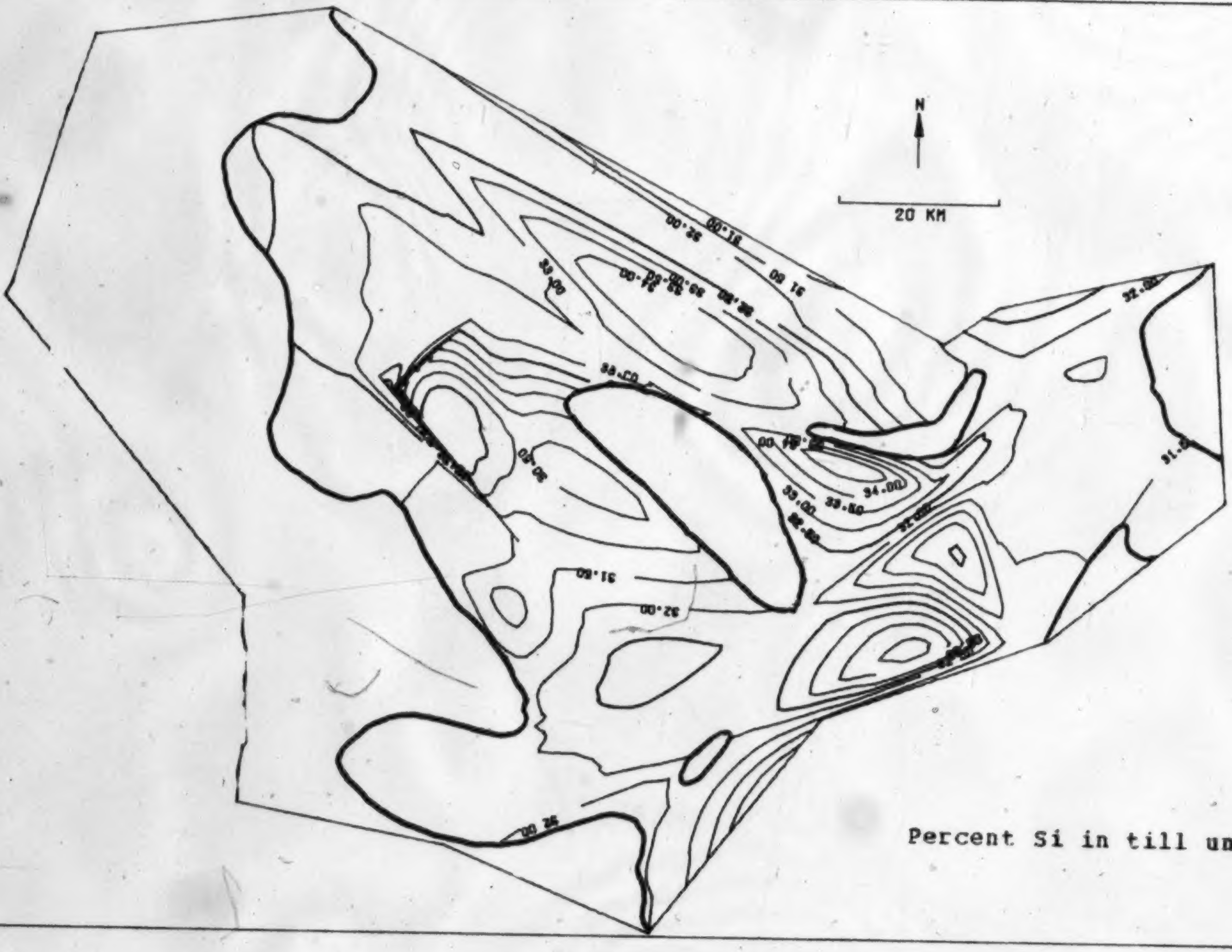
Percent Na in till unit 2.


N
20 KM
1.00
1.20
1.40
1.60
1.80
2.00
2.20

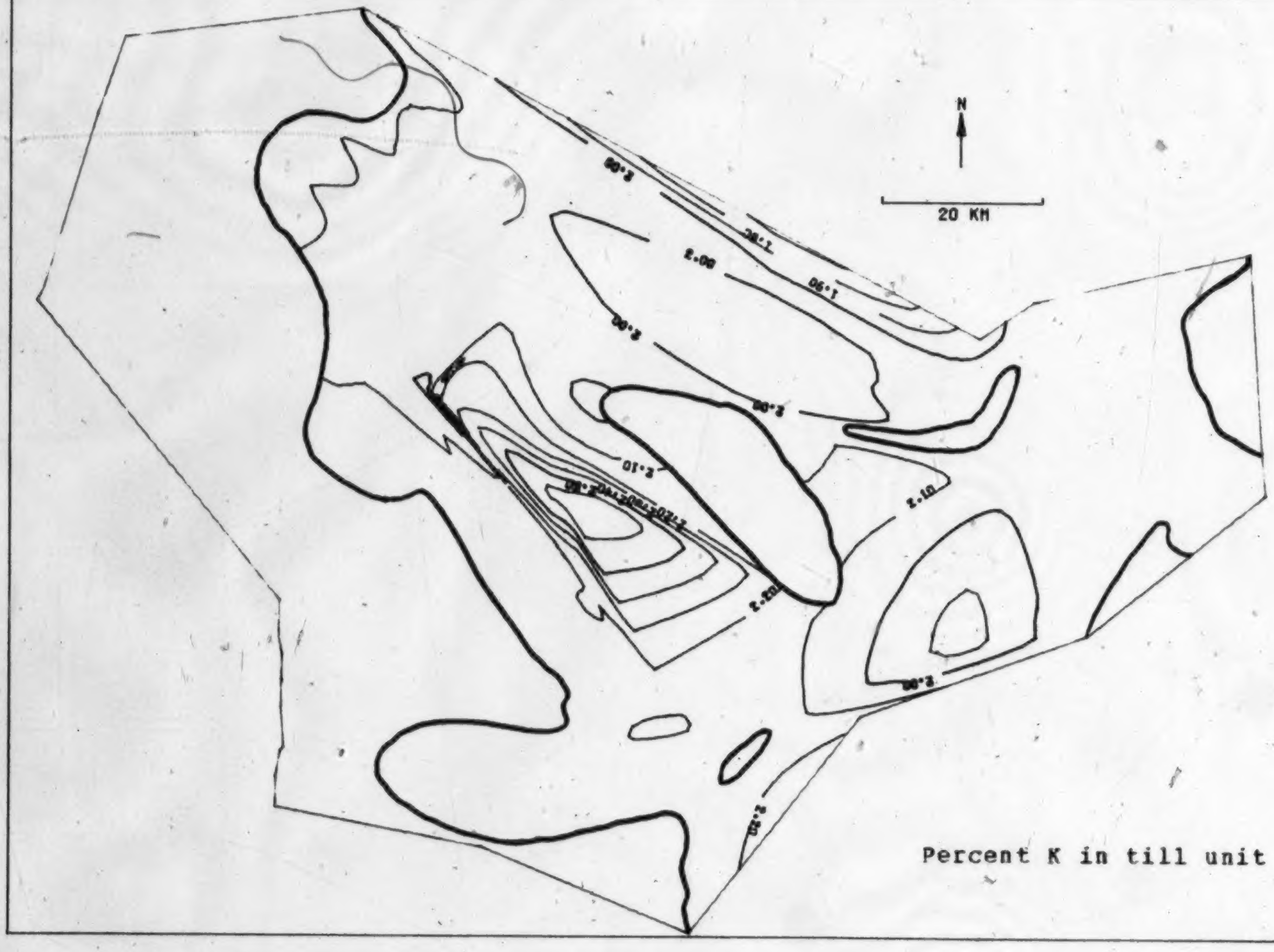
Percent Mg in till unit 2.


N
20 KM
7.20
7.40
7.60
7.80
7.00
6.80

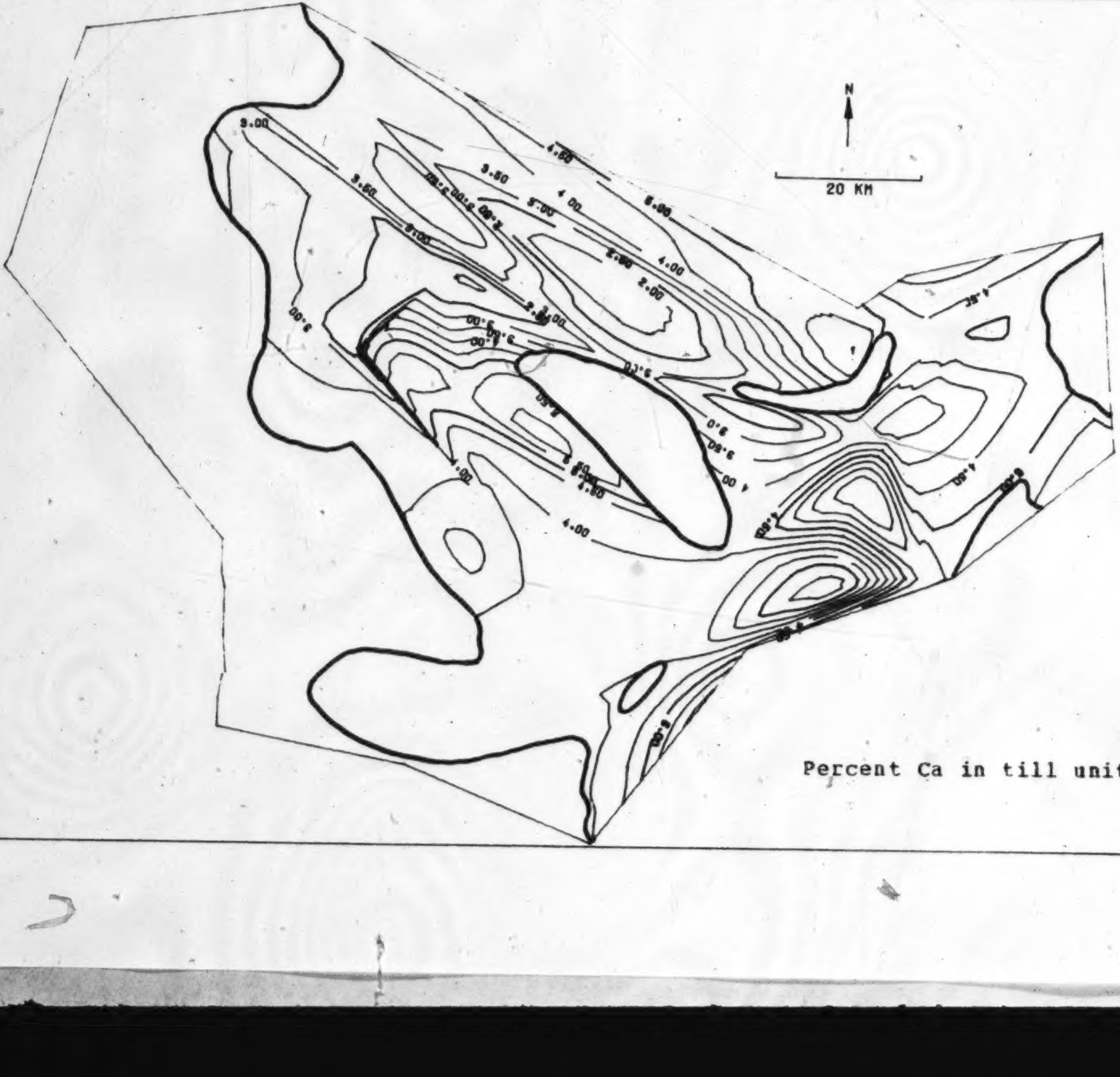
Percent Al in till unit 2.


N
20 KM
31.00
32.00
33.00
34.00
33.50
32.50
31.50
32.00
31.50

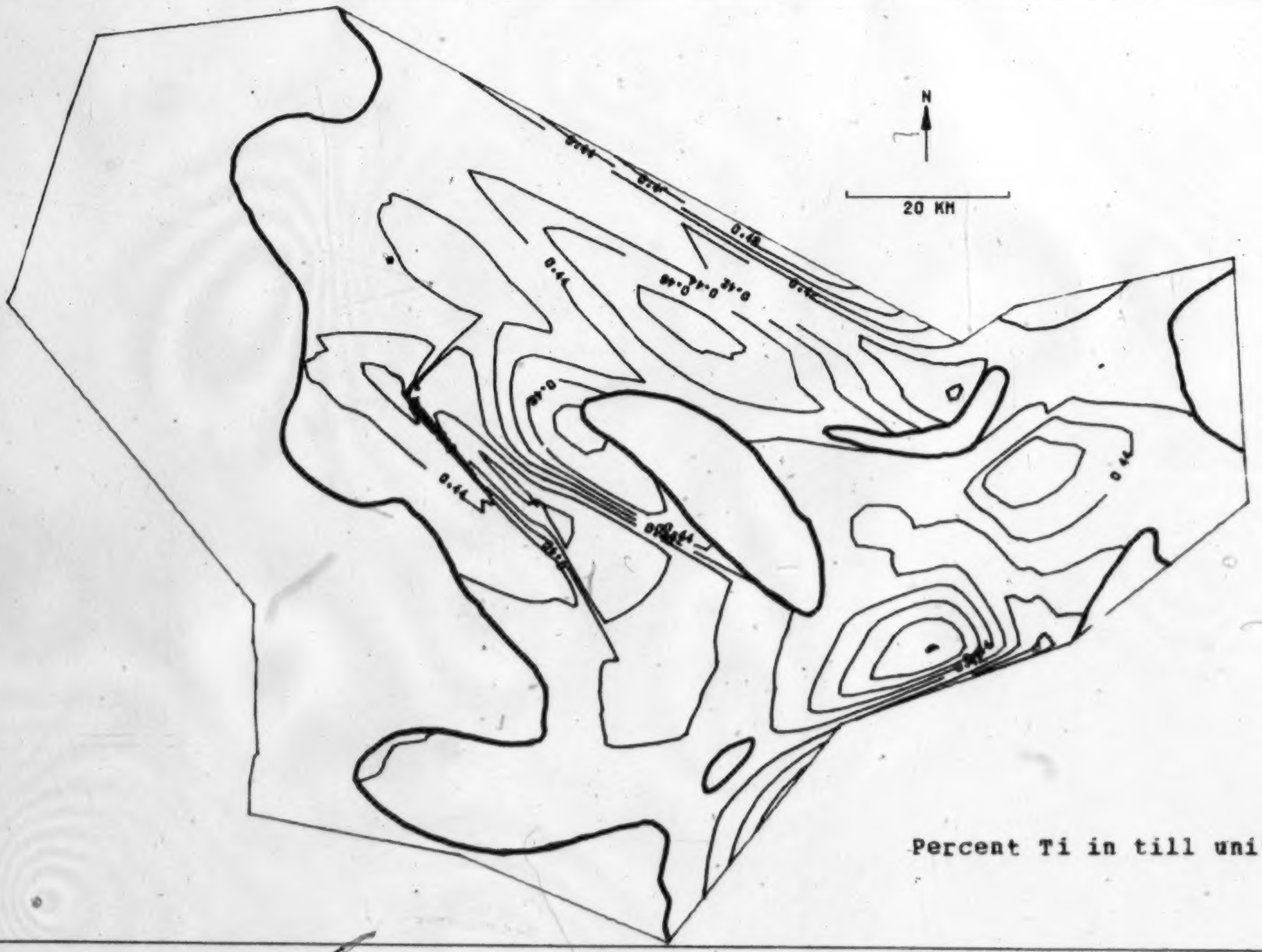
Percent Si in till unit 2.


N
20 KM
2.00
1.90
2.10
2.20

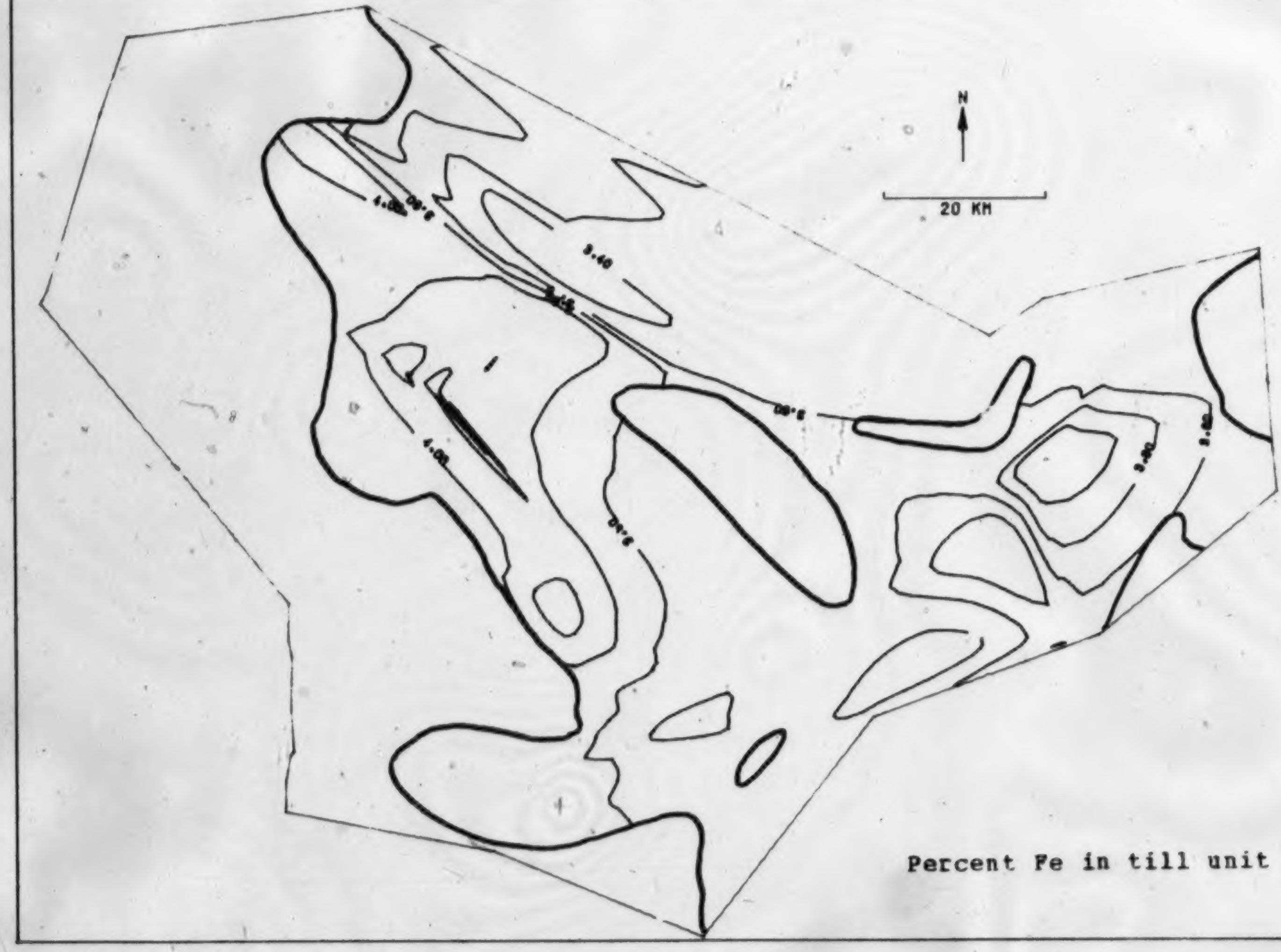
Percent K in till unit 2.


N
20 KM
3.00
3.50
4.00
4.50
2.00
5.00
6.00

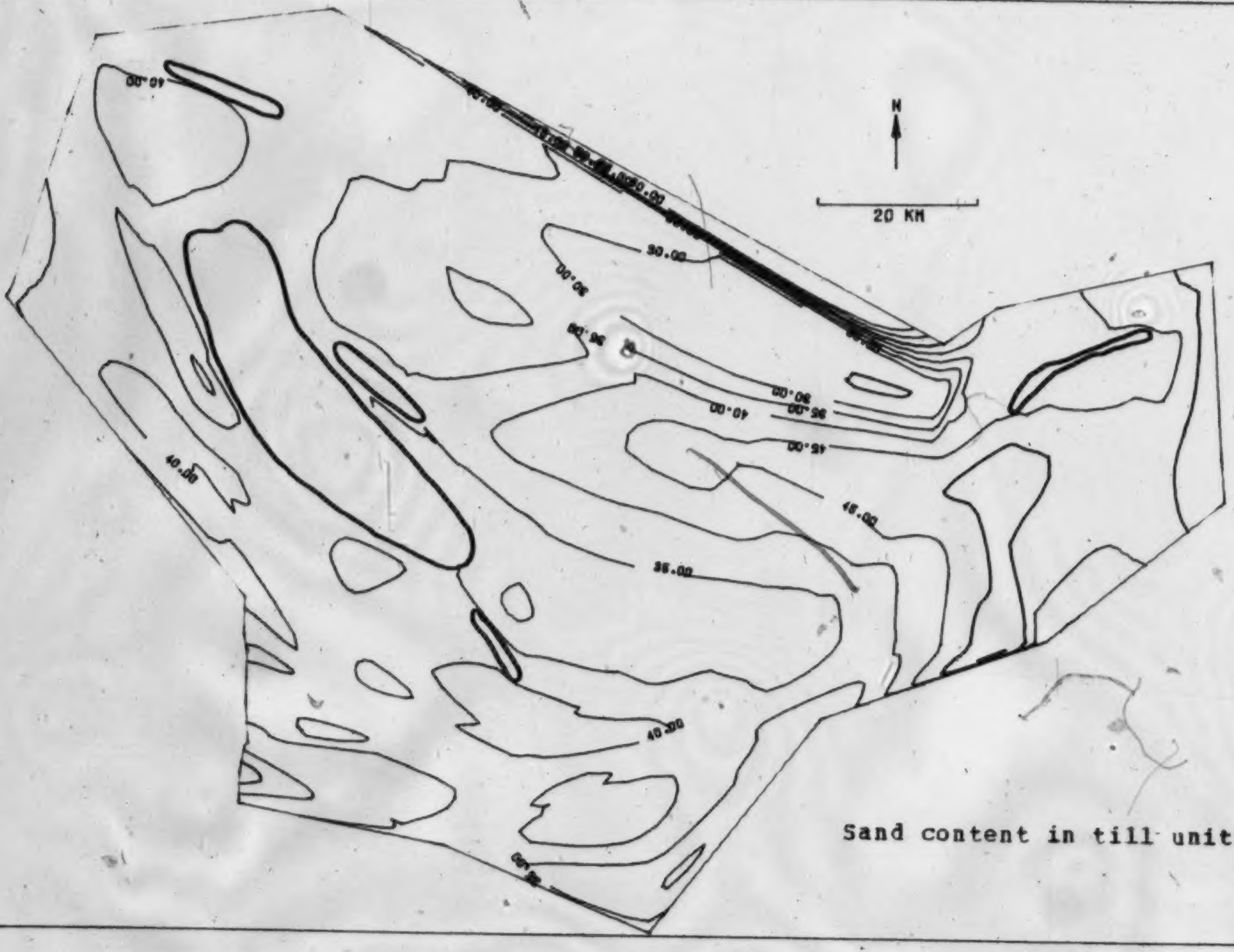
Percent Ca in till unit 2.


N
20 KM
0.44
0.48
0.46
0.42

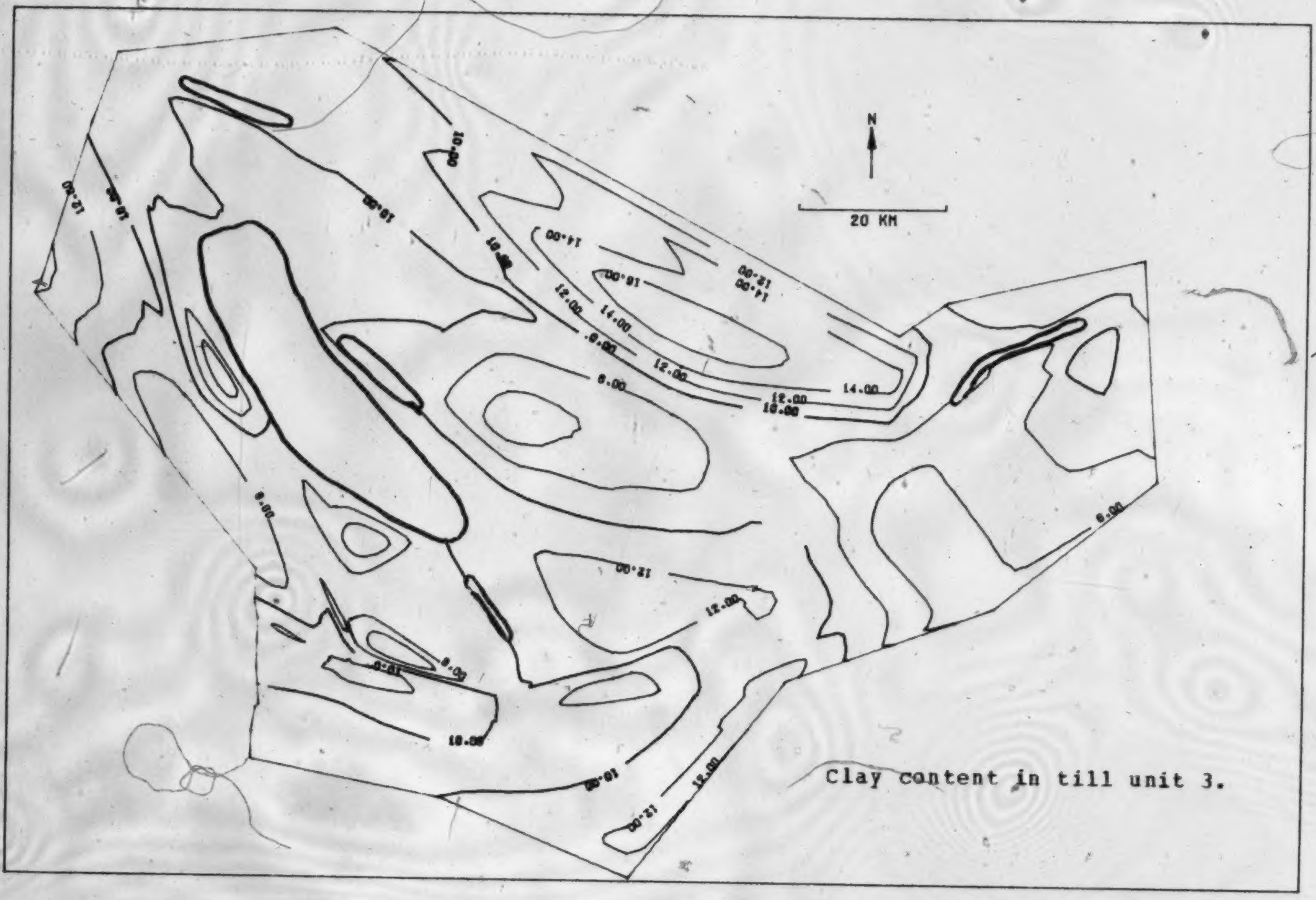
Percent Ti in till unit 2.


N
20 KM
4.00
3.60
3.40
4.00
3.60
3.60
3.60
3.60

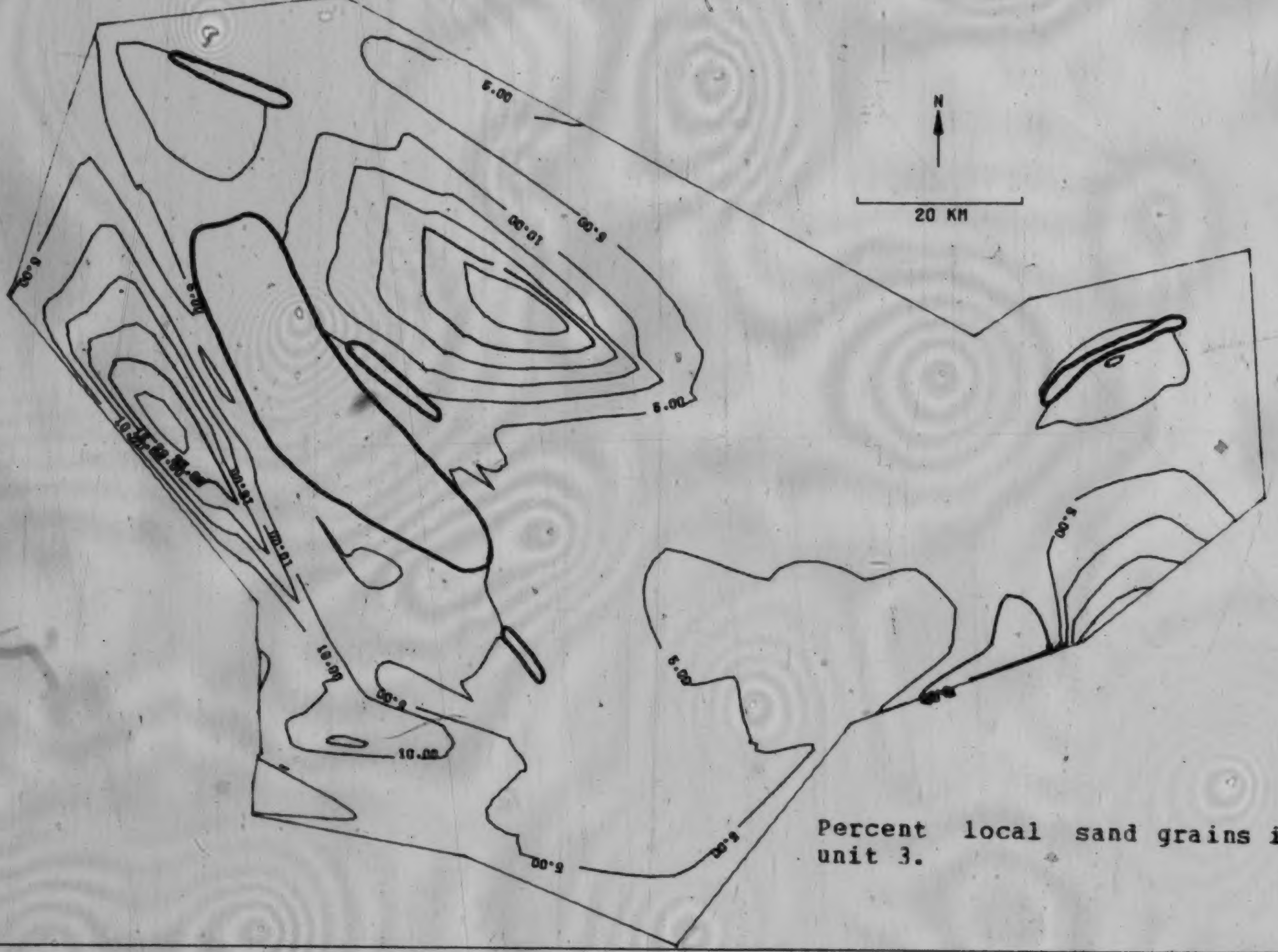
Percent Fe in till unit 2.


N
20 KM
40.00
30.00
35.00
40.00
45.00
45.00
35.00
40.00
40.00
30.00

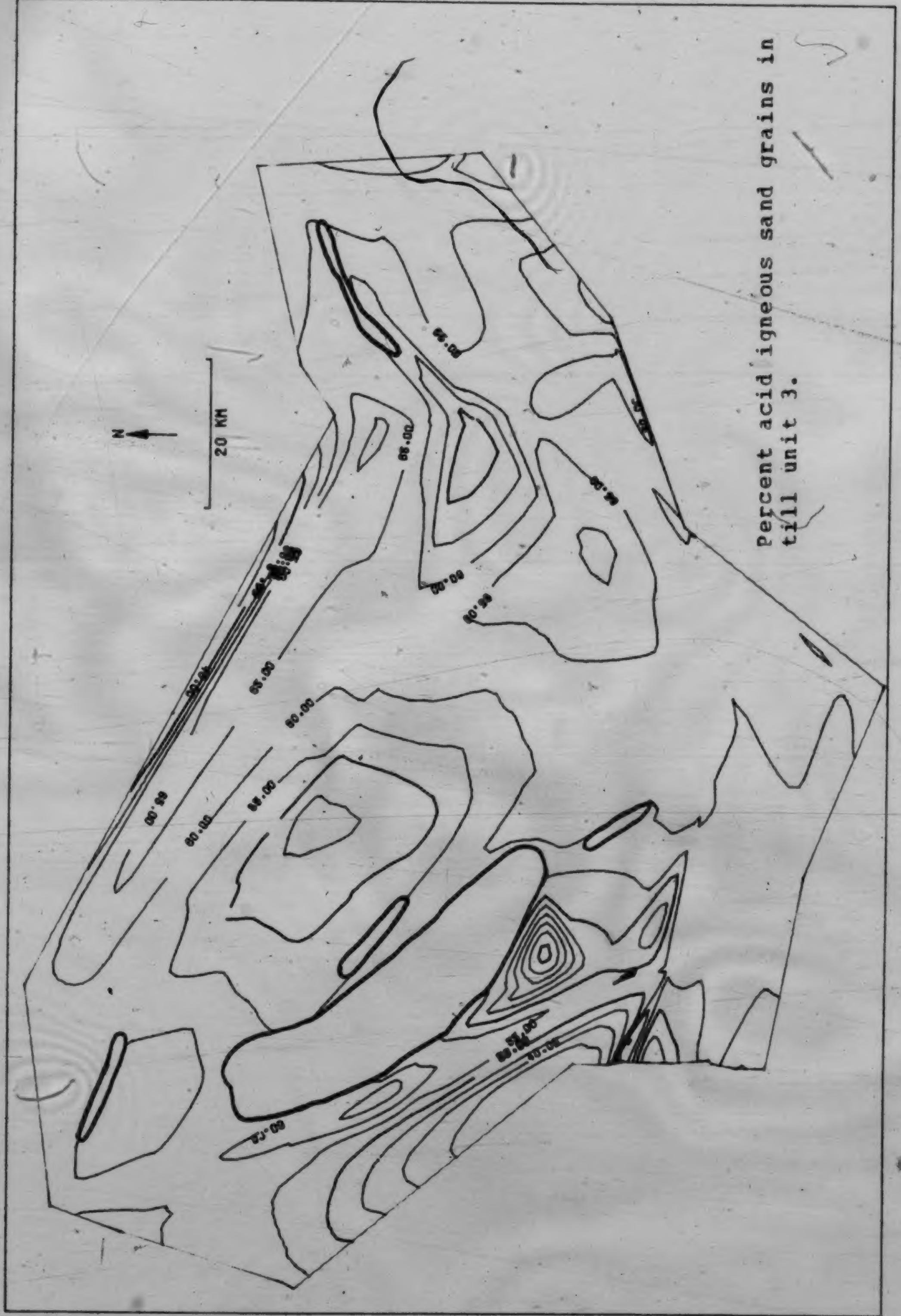
Sand content in till unit 3.


N
20 KM
12.00
10.00
10.00
10.00
14.00
16.00
12.00
14.00
12.00
14.00
8.00
12.00
12.00
14.00
10.00
8.00
8.00
12.00
12.00
8.00
10.00
8.00
10.00
10.00
12.00
12.00

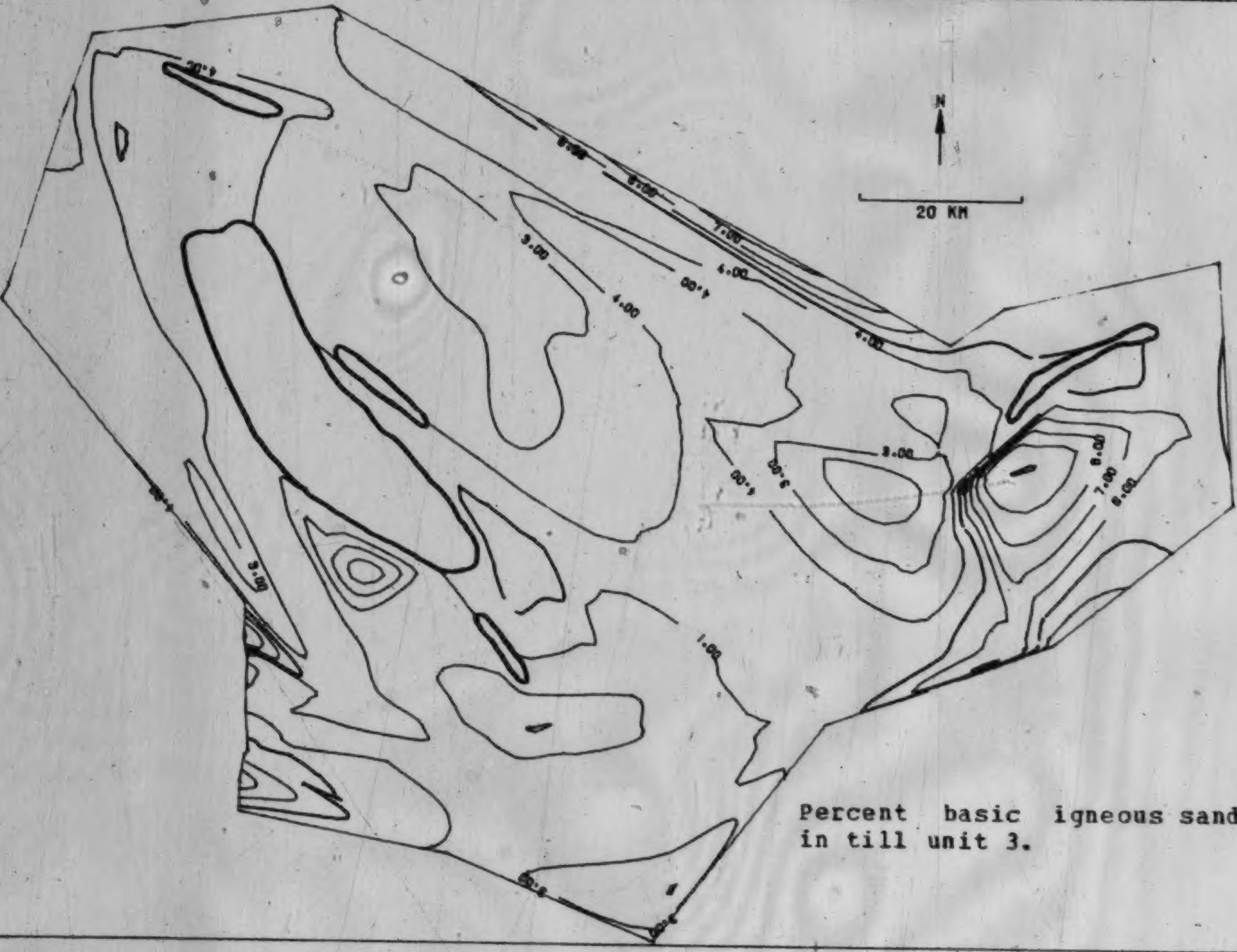
Clay content in till unit 3.


N
20 KM
5.00
10.00

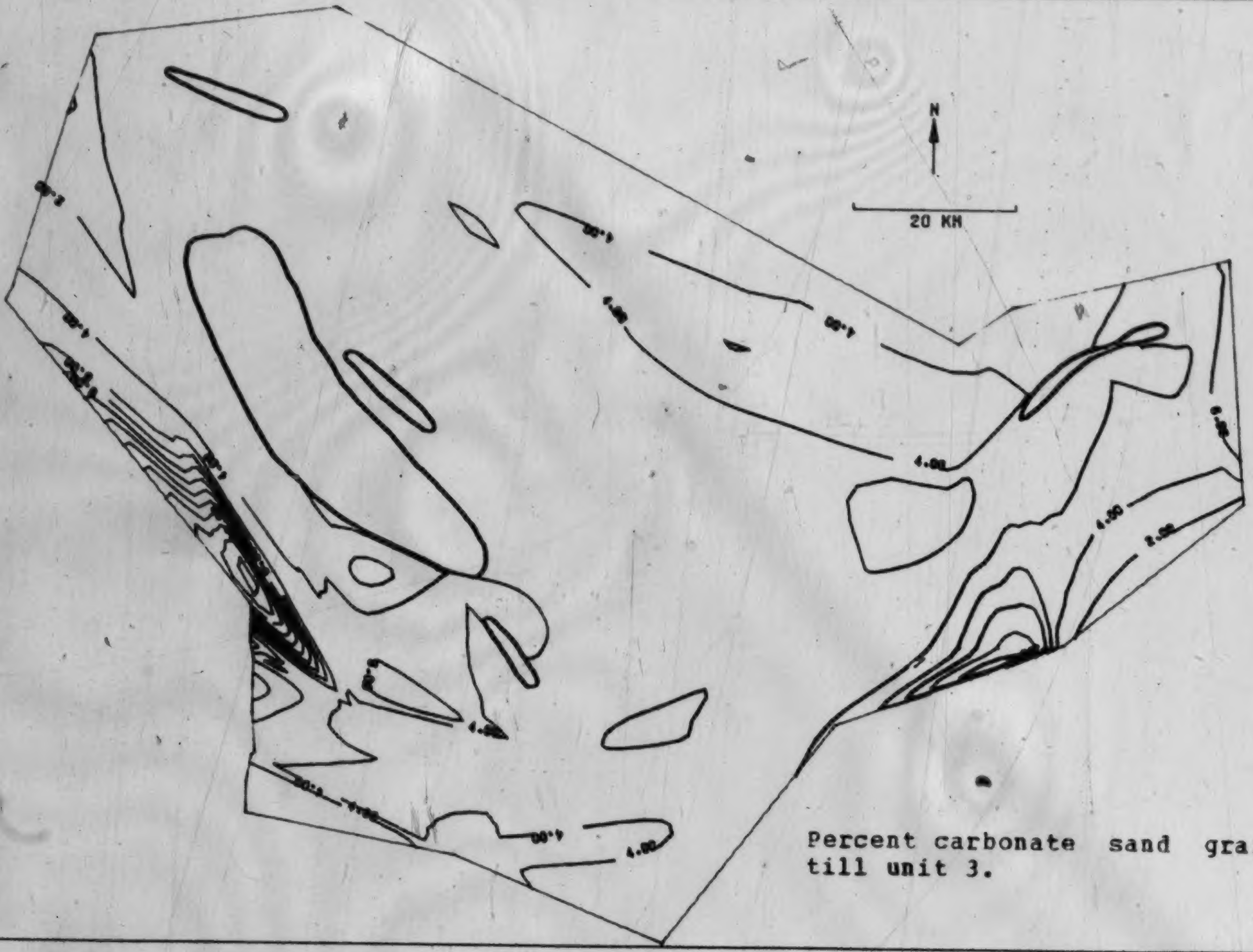
Percent local sand grains in till unit 3.



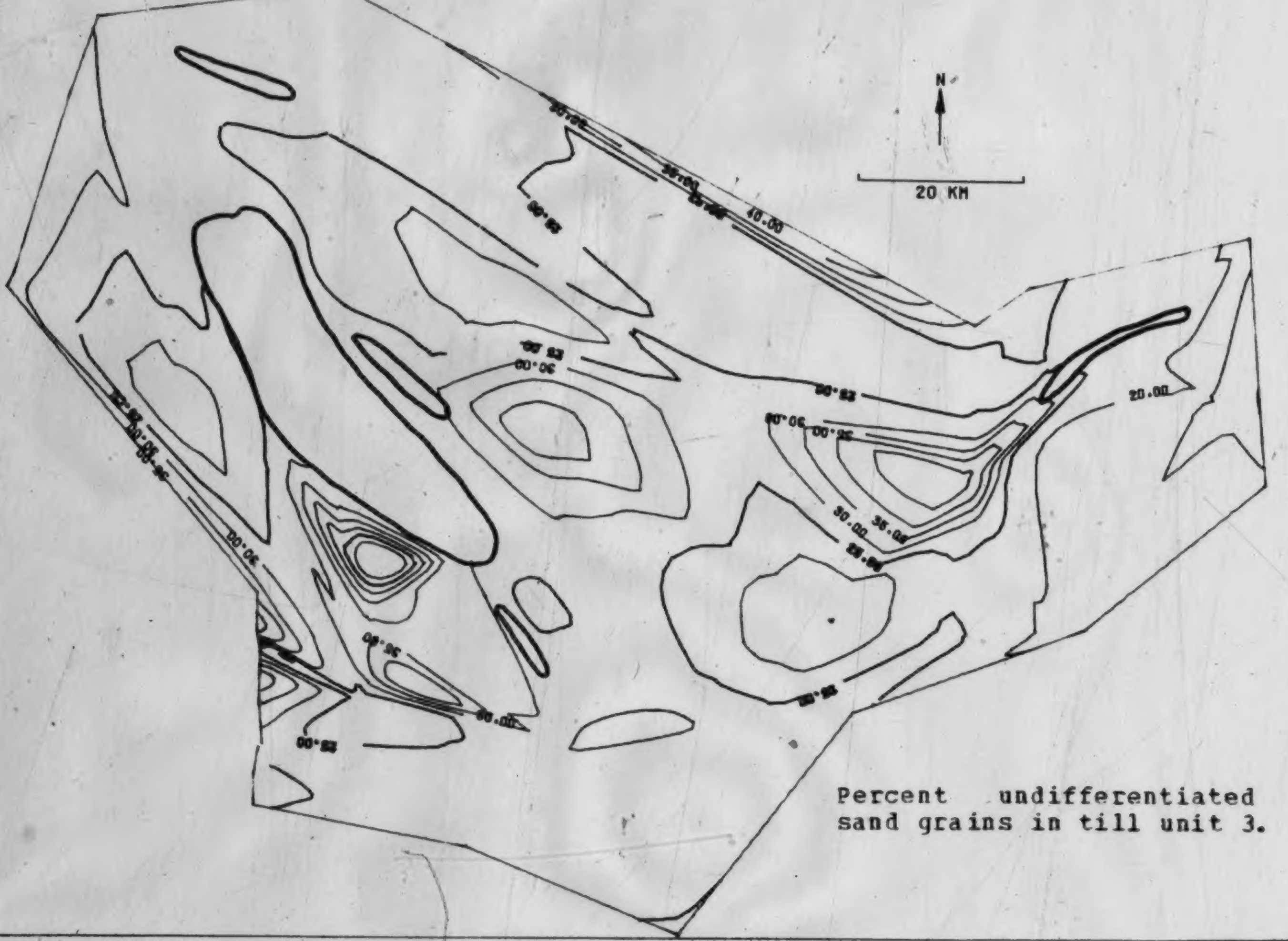
Percent acid igneous sand grains in till unit 3.


N
20 KM
8.00
6.00
7.00
4.00
3.00
4.00
4.00
4.00
3.00
4.00
3.00
6.00
7.00
8.00
1.00
4.00
3.00

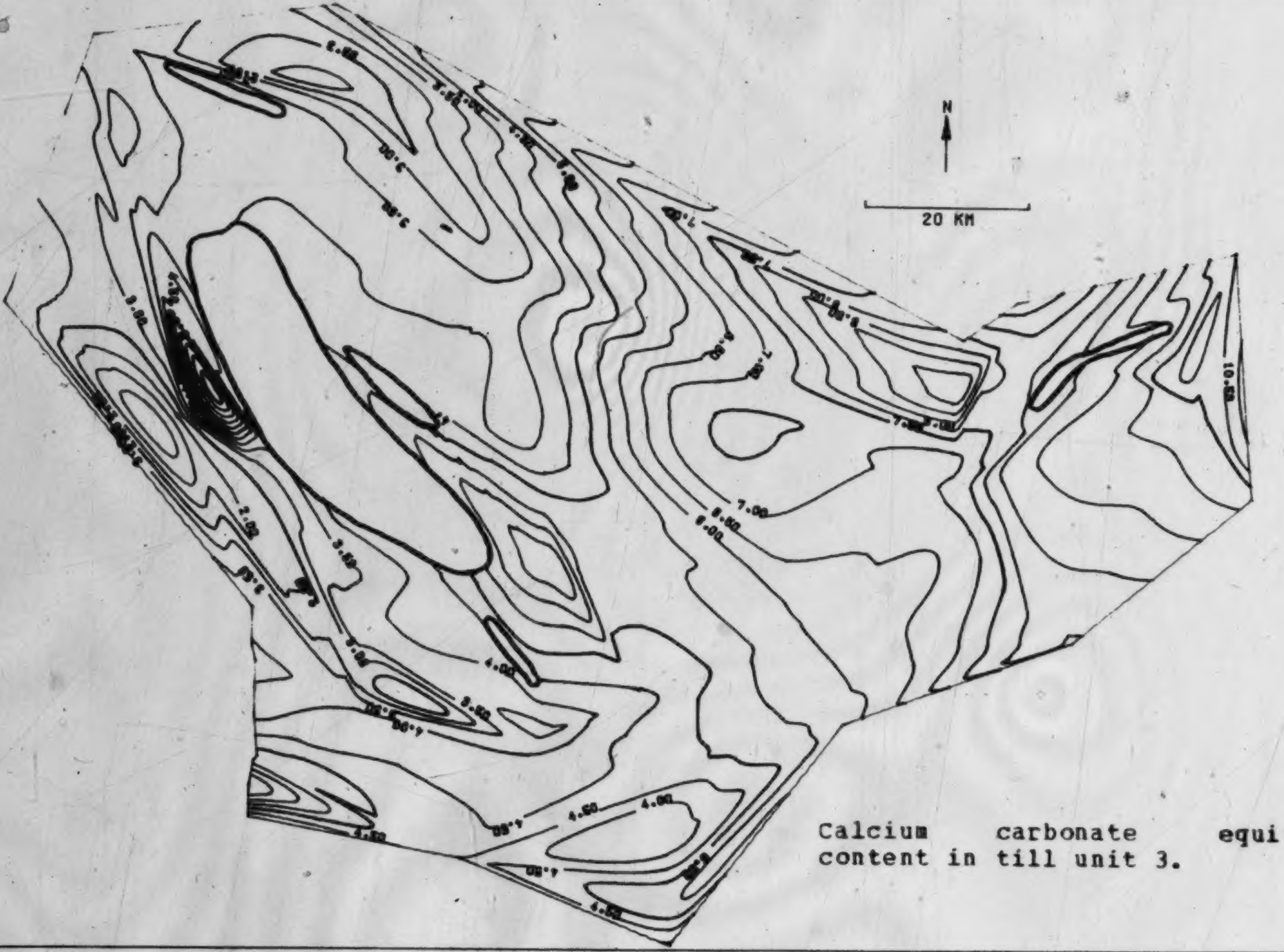
Percent basic igneous sand grains in till unit 3.


N
20 KM
4.00
2.00

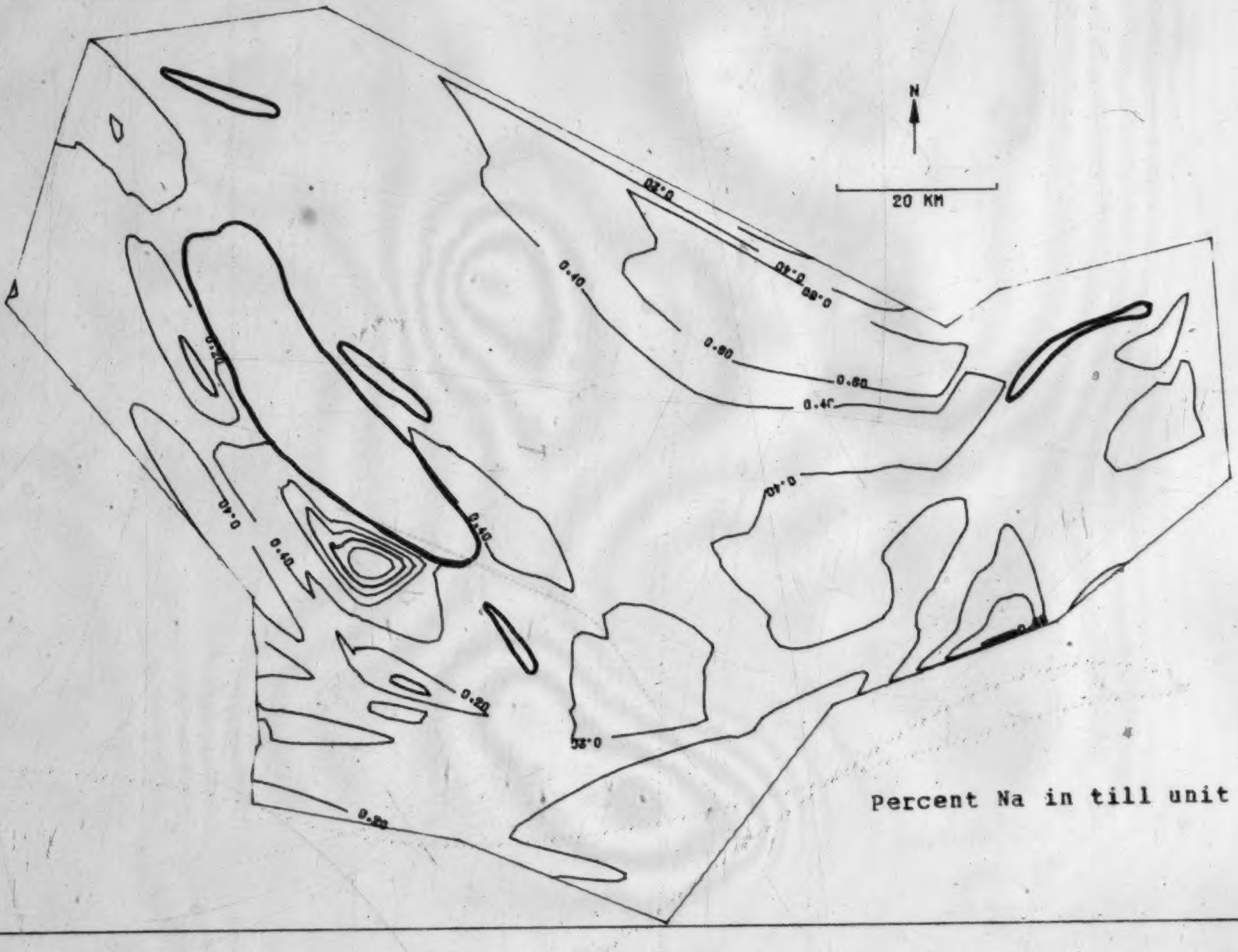
Percent carbonate sand grains in till unit 3.


N
20 KM
20.00
25.00
30.00
35.00
40.00

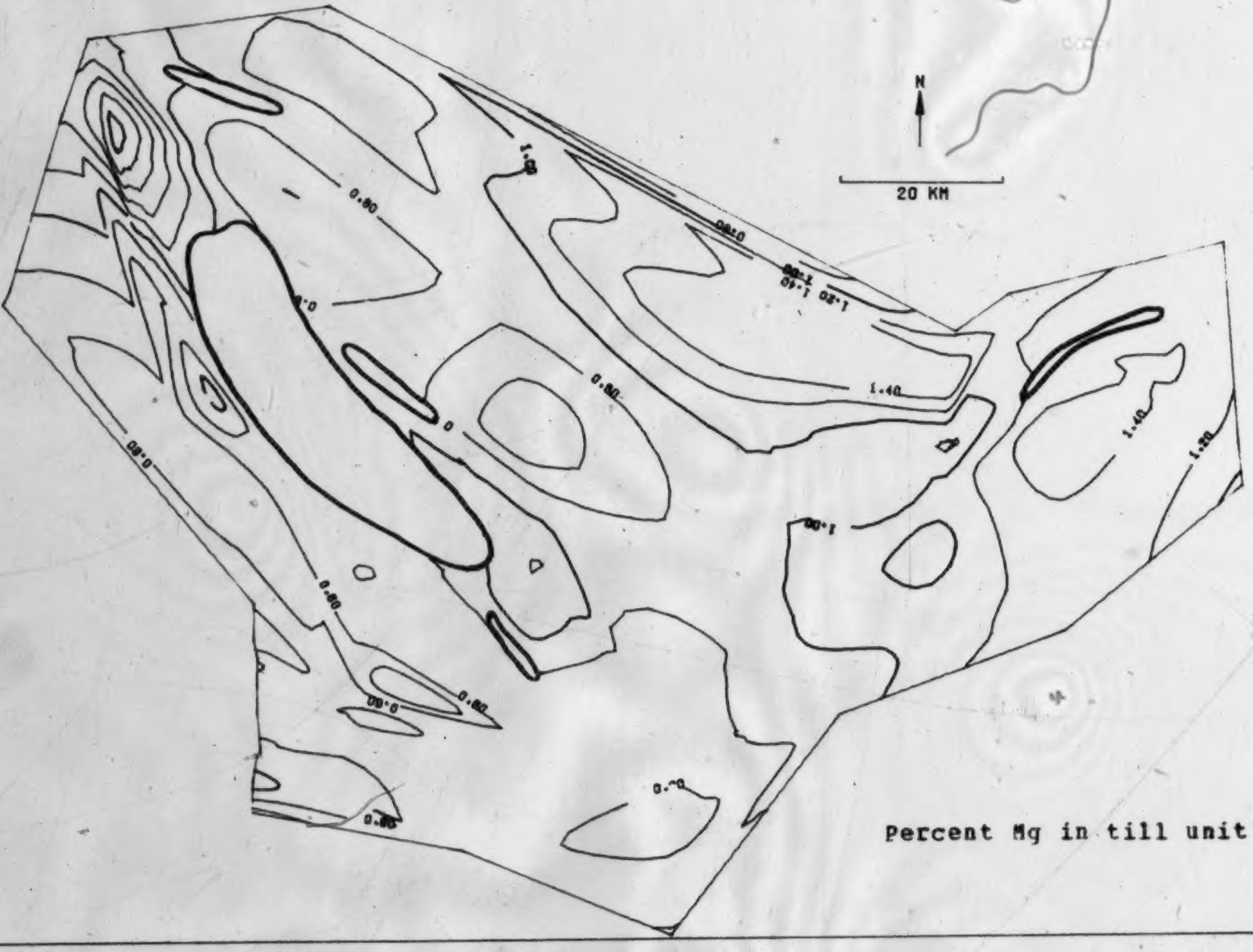
Percent undifferentiated quartz sand grains in till unit 3.


N
20 KM
10.50
7.00
6.50
6.00
4.00
4.50
3.00
3.50
2.00

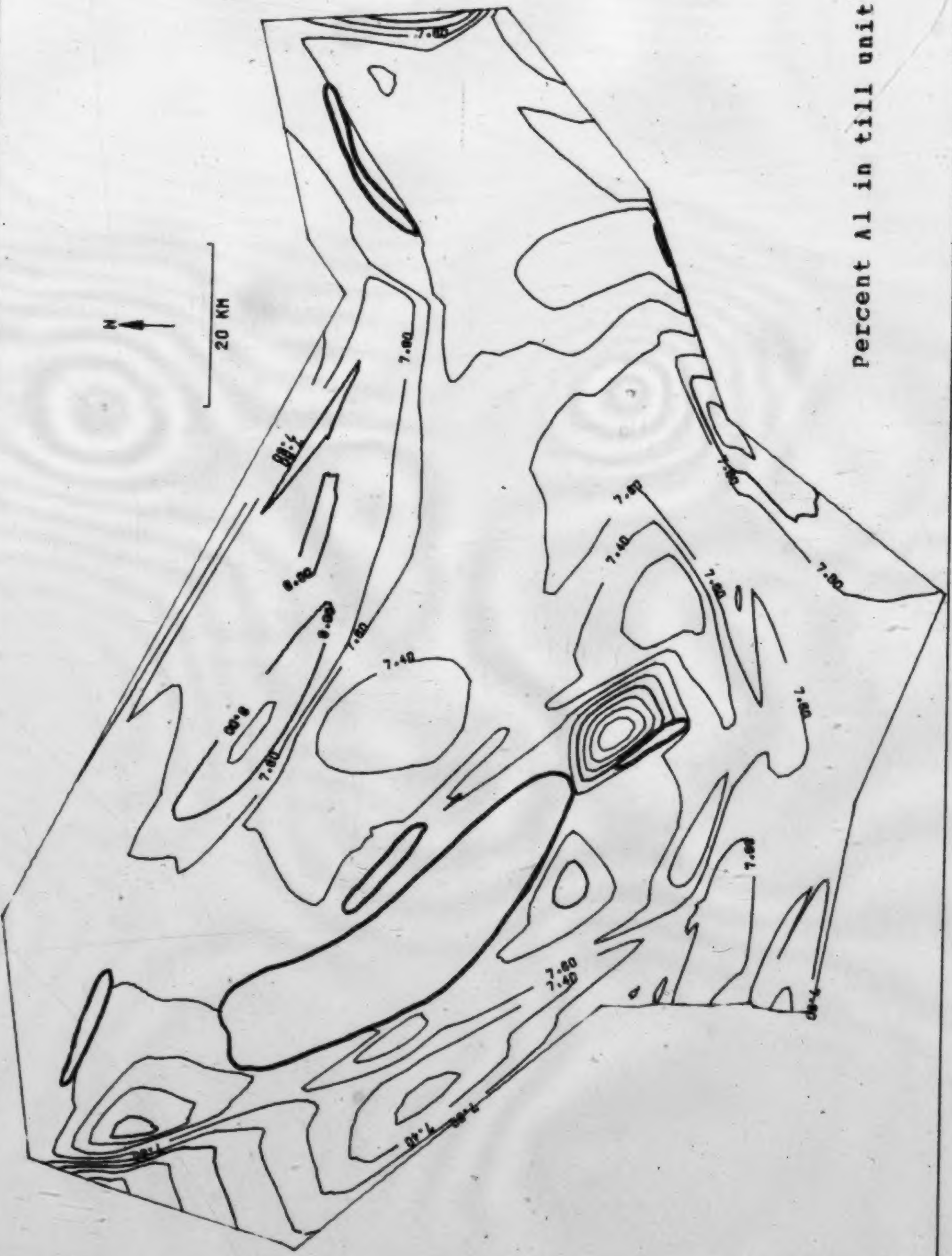
Calcium carbonate equivalent content in till unit 3.


N
20 KM
0.20
0.40
0.60
0.40
0.60
0.60
0.40
0.40
0.40
0.20
0.40
0.40
0.40
0.20
0.20
0.35
0.20

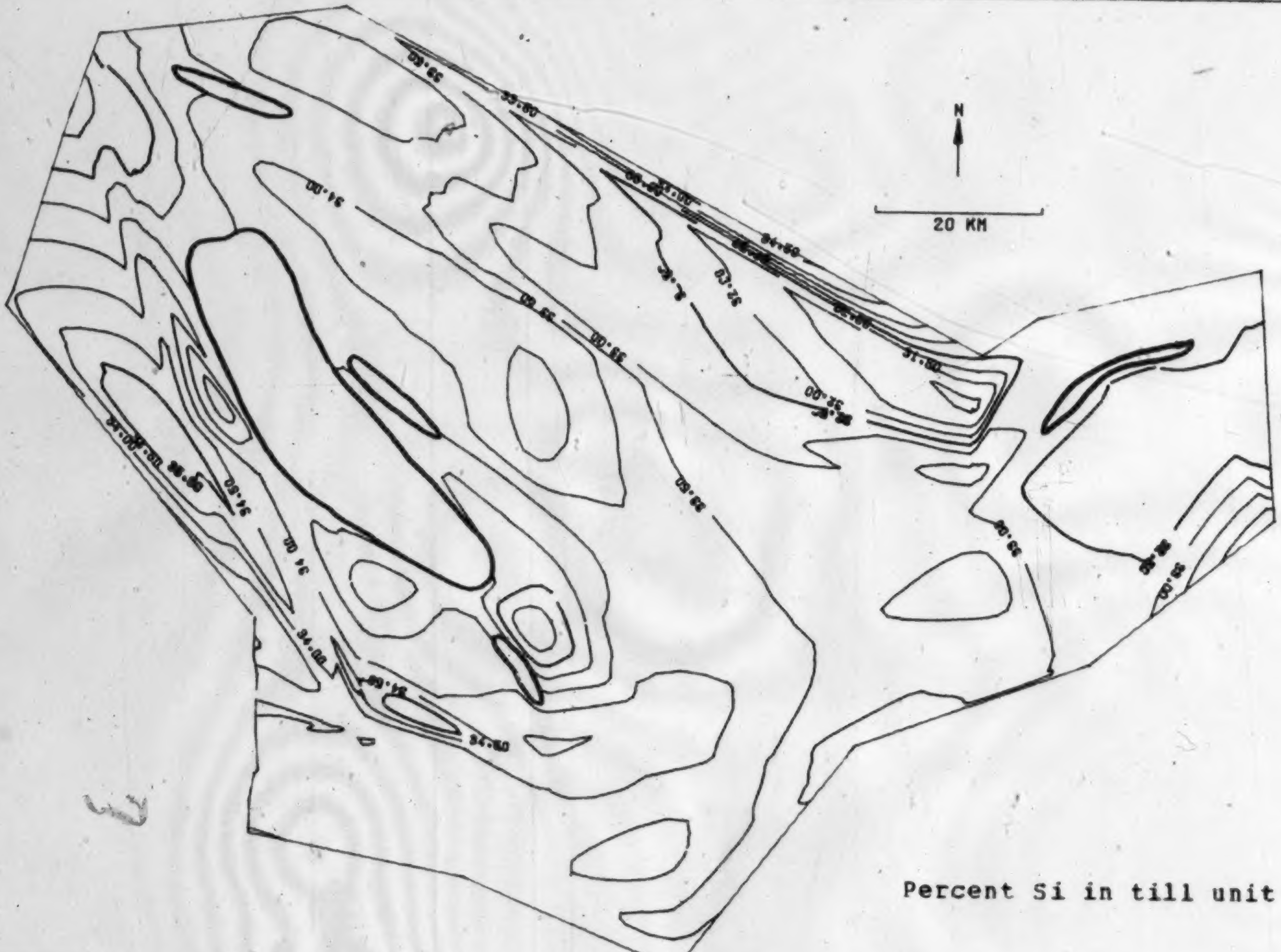
Percent Na in till unit 3.


N
20 KM
1.40
1.20
1.00
0.80
0.60
0

Percent Mg in till unit 3.

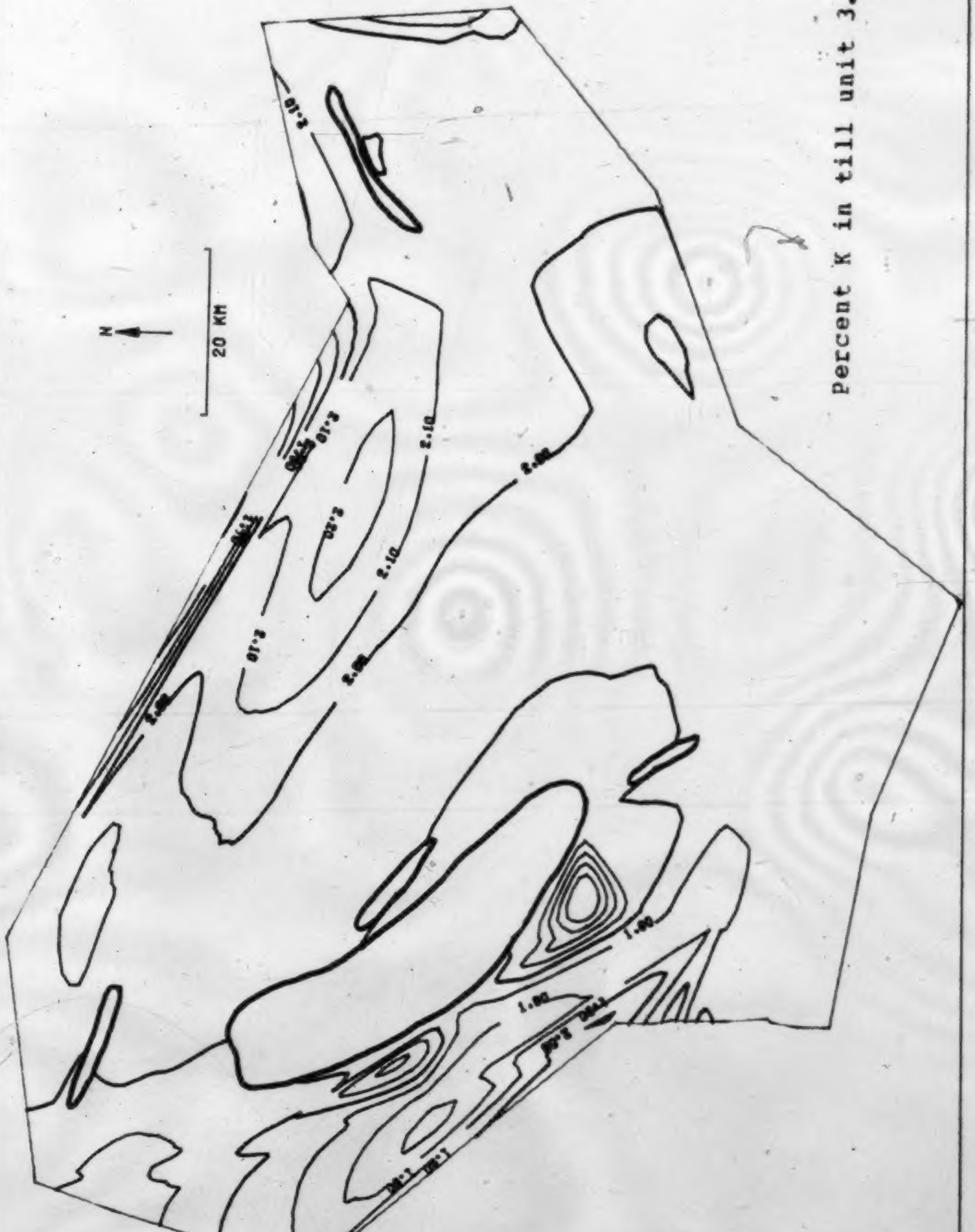

N
20 KM
7.80
7.40
8.00

Percent Al in till unit 3.

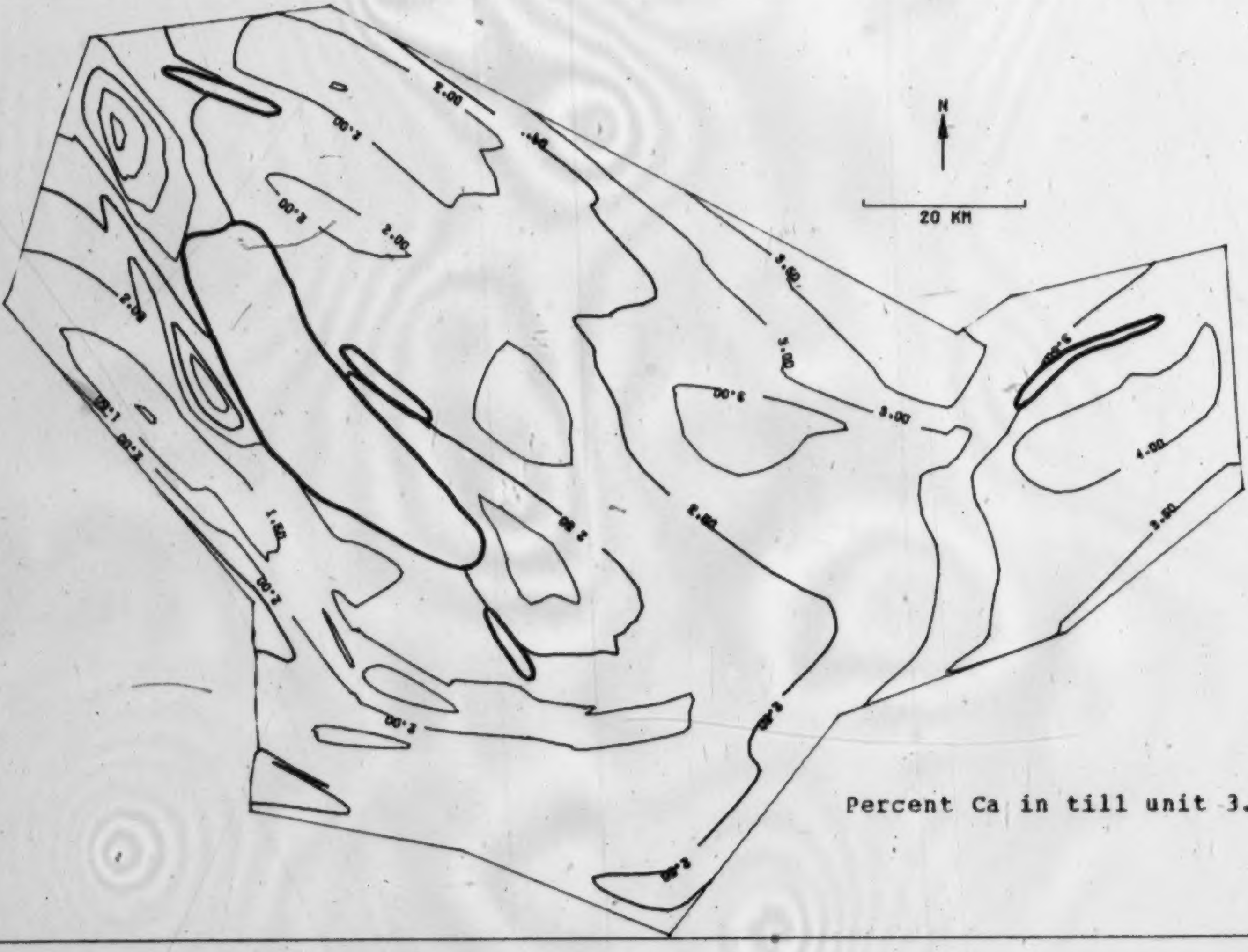

N
20 KM
34.00
33.00
34.50

Percent Si in till unit 3.

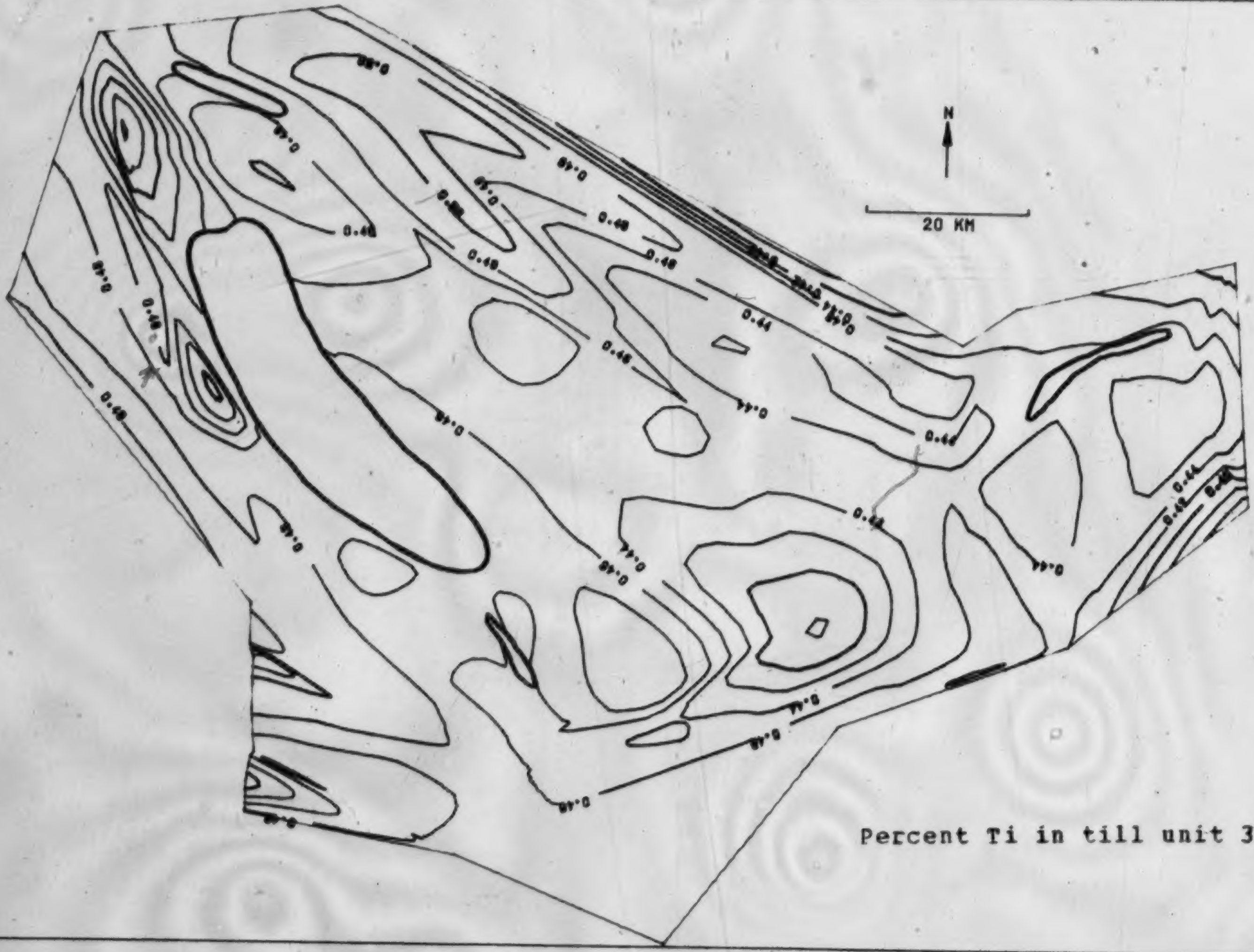
3


N
20 KM
2.10
2.00
1.00

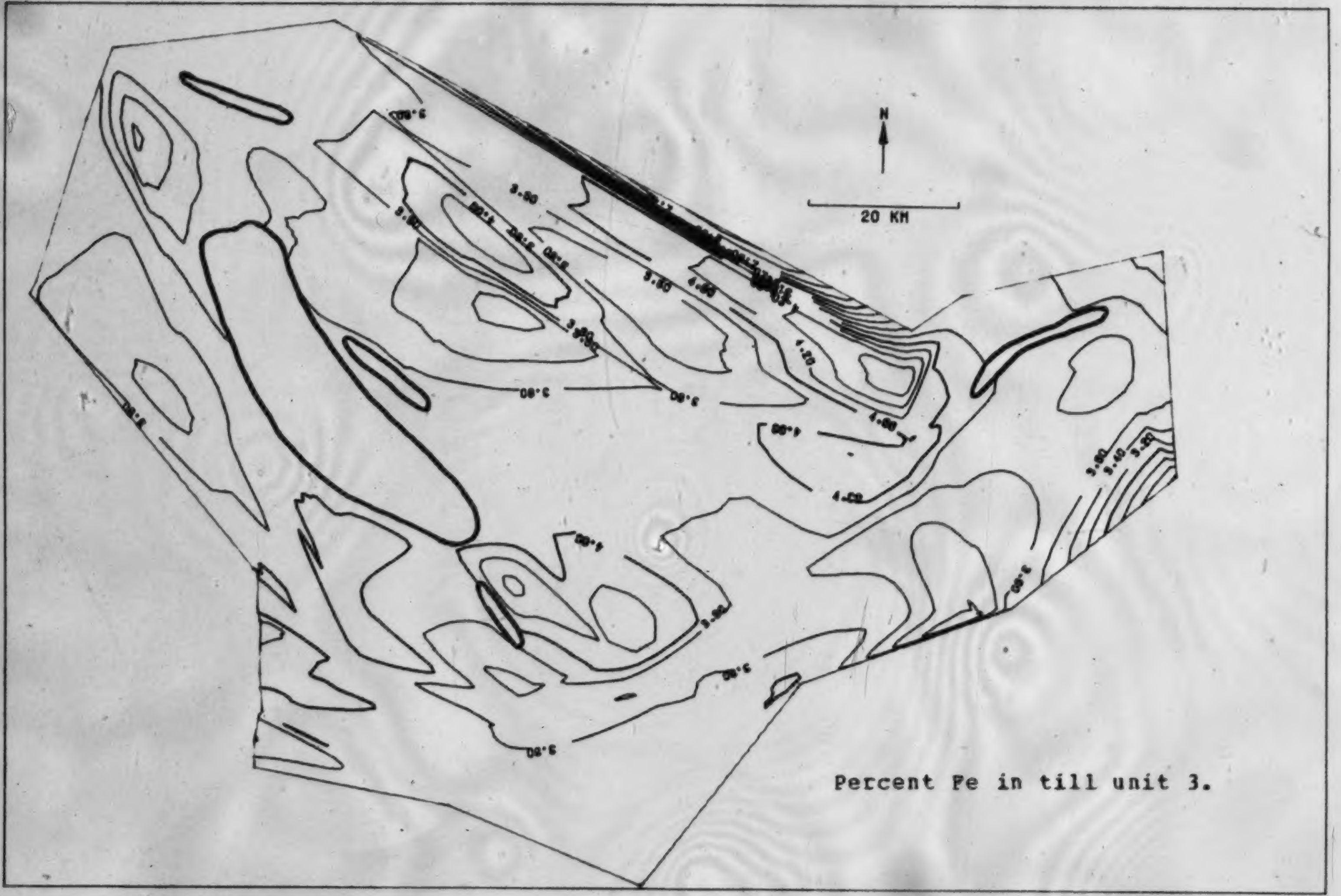
Percent K in till unit 3.


N
20 KM
2.00
3.00
3.50
4.00
2.50
1.50

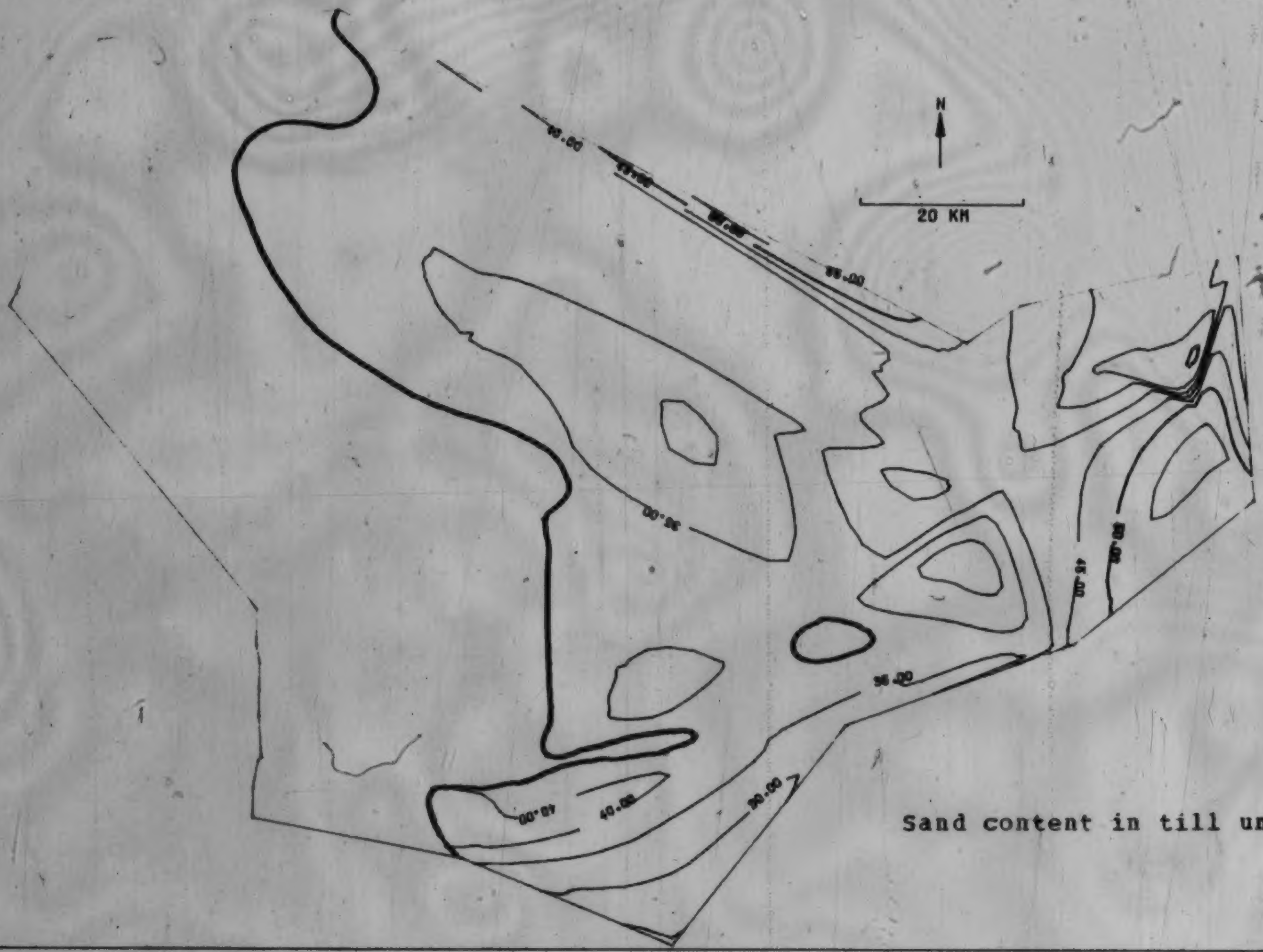
Percent Ca in till unit 3.


N
20 KM
0.44
0.48

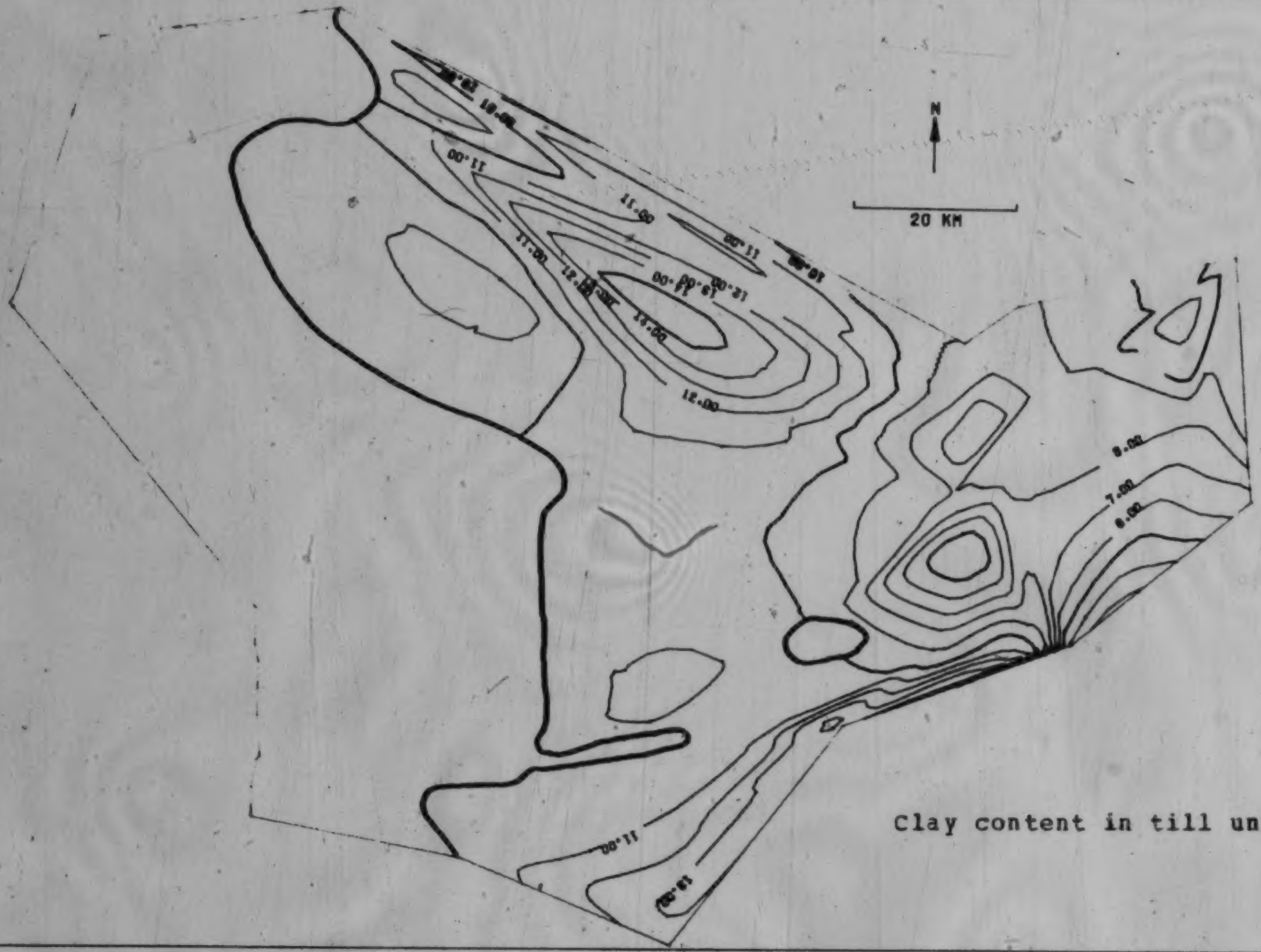
Percent Ti in till unit 3.


N
20 KM
3.60
3.80
4.00
4.20
3.40
3.20

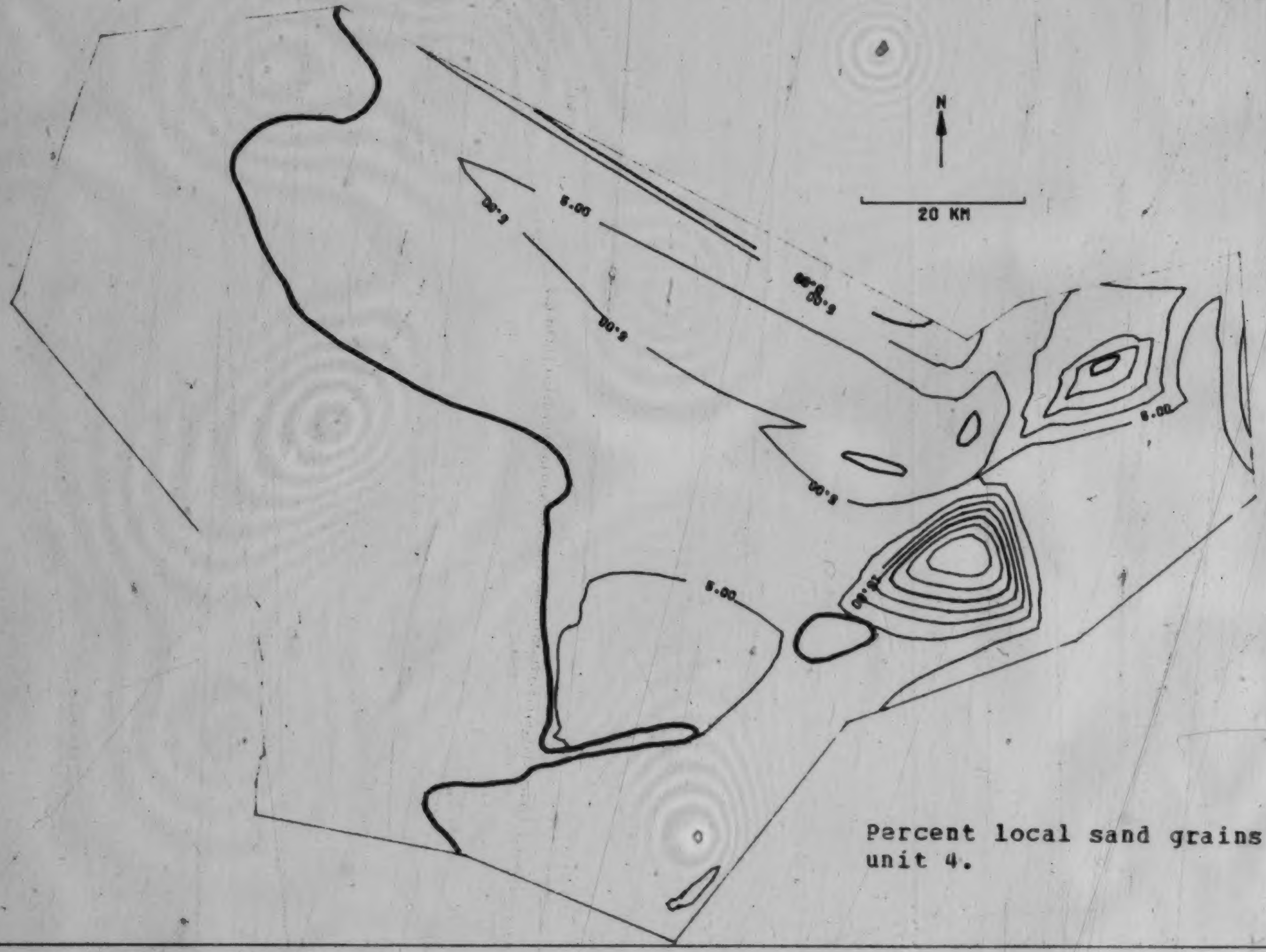
Percent Fe in till unit 3.


N
20 KM
30.00
35.00
40.00
45.00
50.00

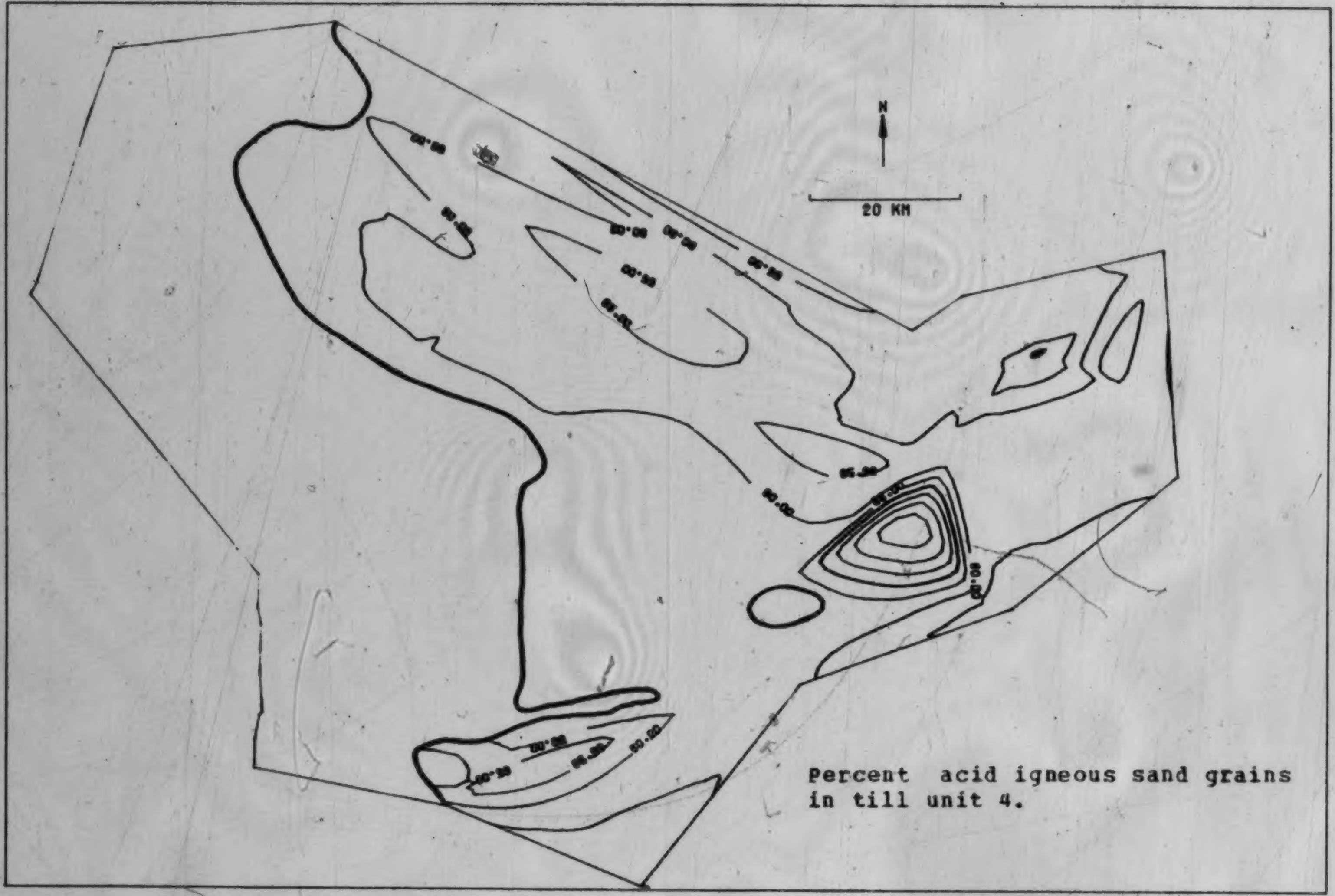
Sand content in till unit 4.


N
20 KM
10.00
11.00
12.00
13.00
14.00
8.00
7.00
6.00

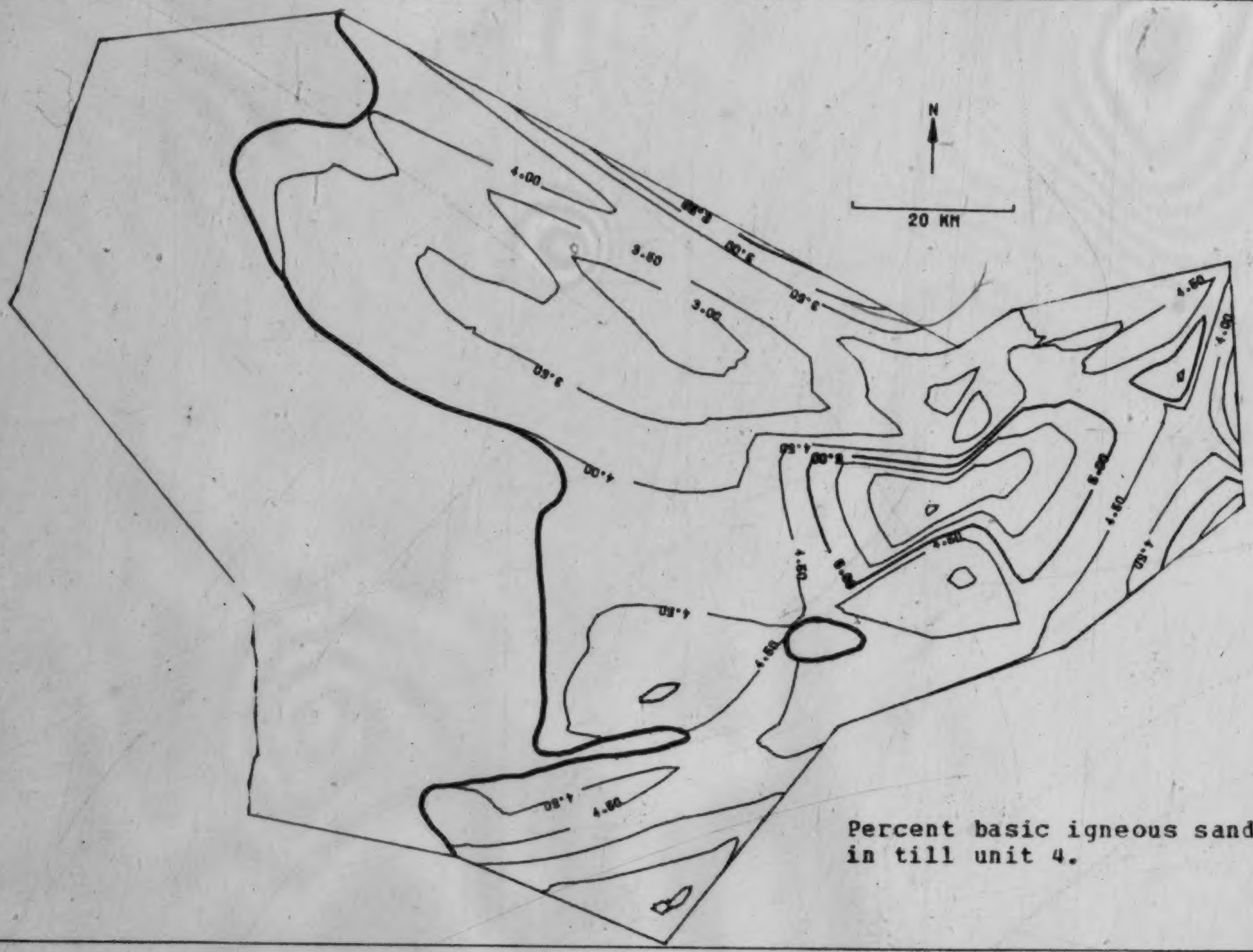
Clay content in till unit 4.


N
20 KM
5.00
5.00
5.00
5.00
5.00
5.00
5.00
5.00
15.00

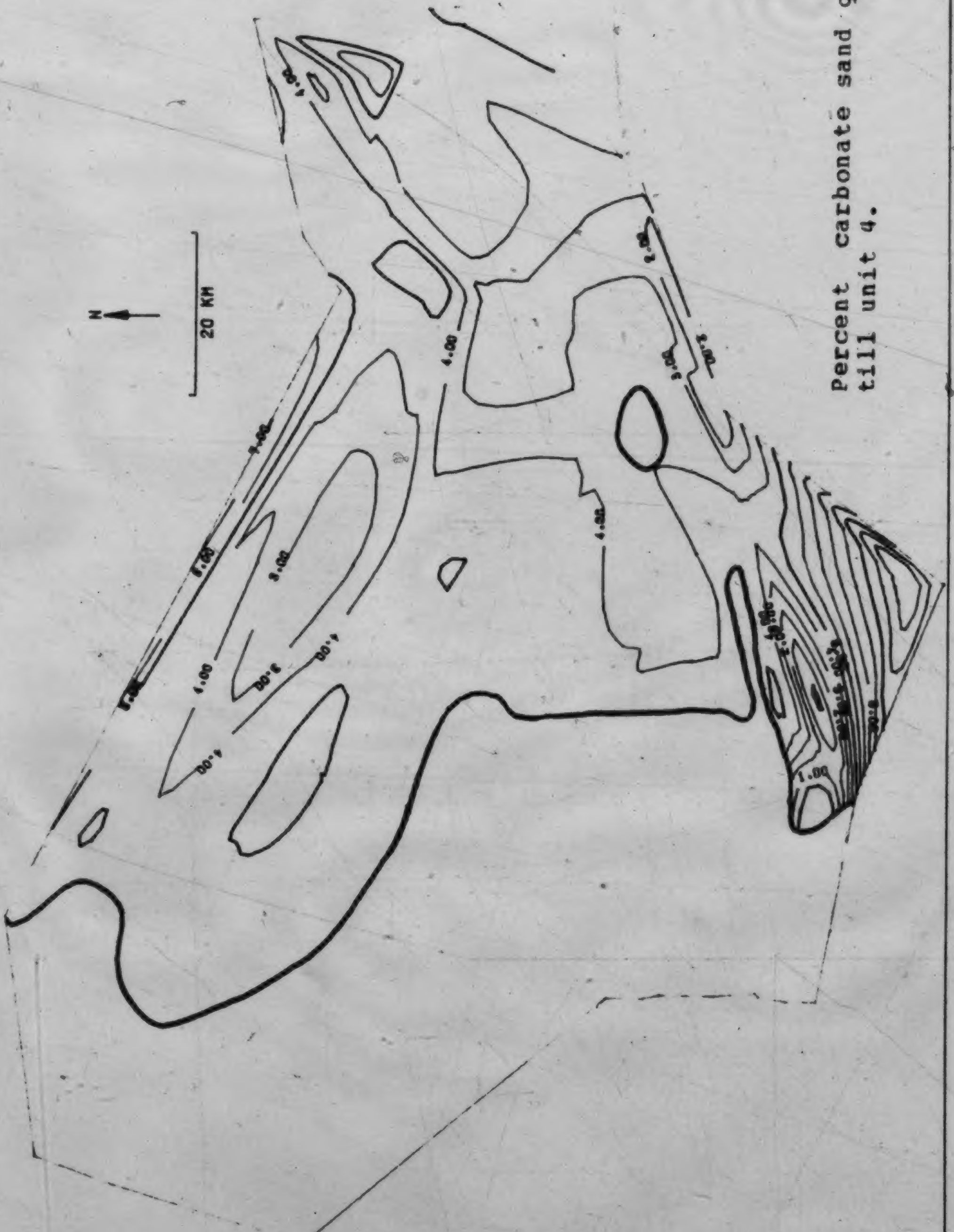
Percent local sand grains in till unit 4.


N
20 KM
85.00
80.00
80.00

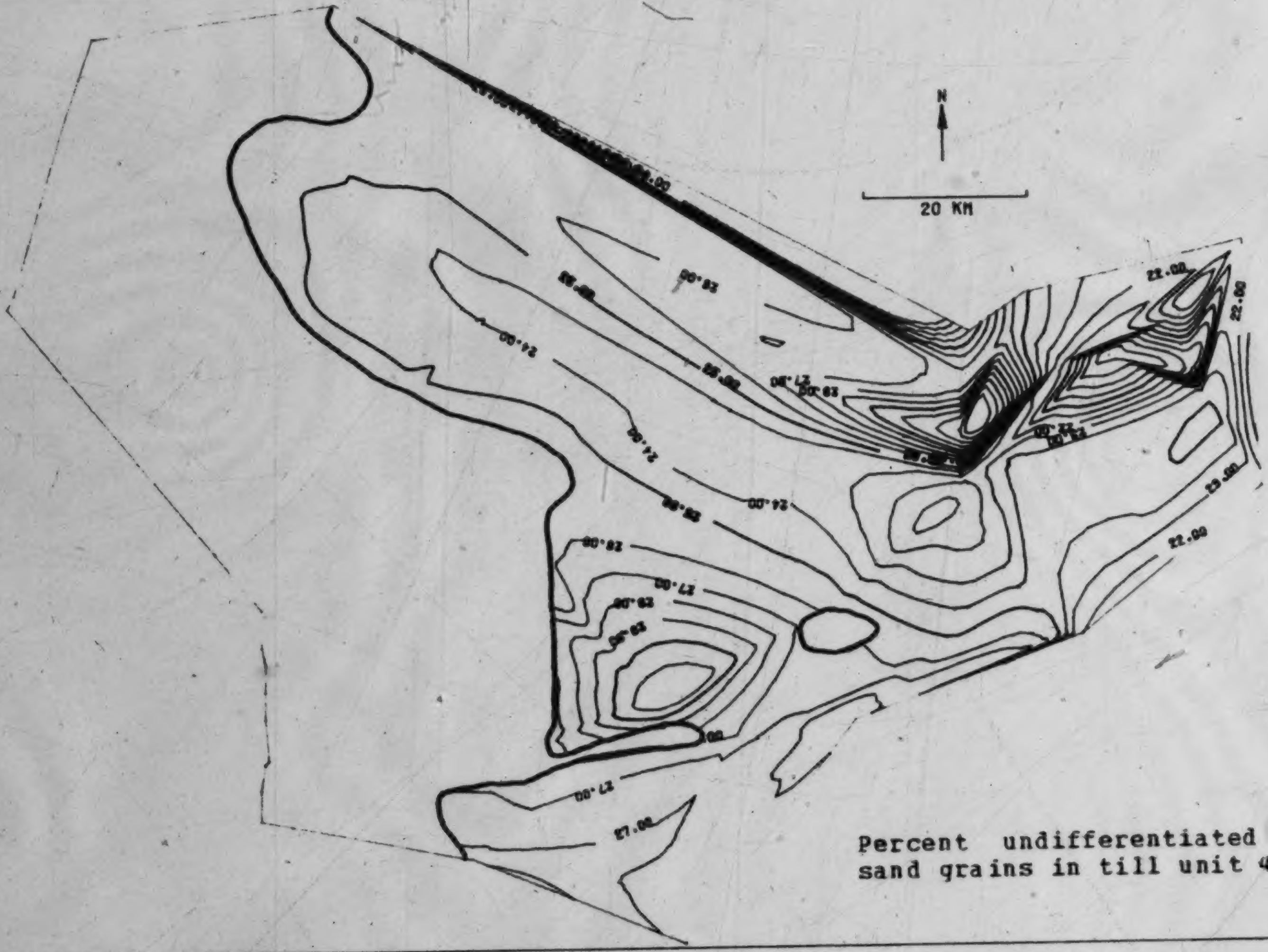
Percent acid igneous sand grains
in till unit 4.


N
20 KM
4.00
3.60
3.00
3.60
3.00
3.60
4.00
5.00
4.50
4.50
5.00
4.50
4.50
4.00
4.50
4.50
4.50
4.50

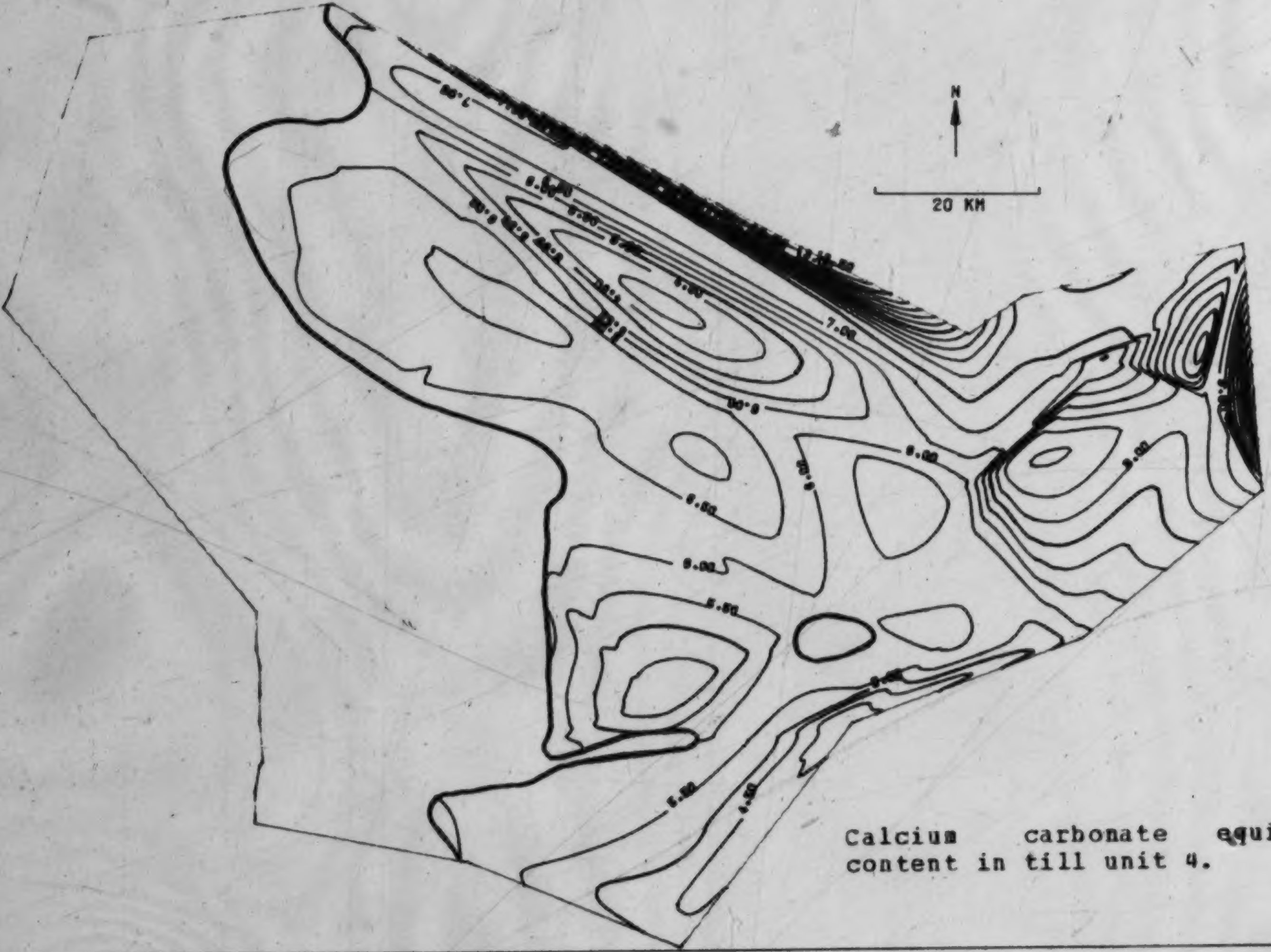
Percent basic igneous sand grains
in till unit 4.


N
20 KM
1.00
2.00
3.00
4.00
5.00

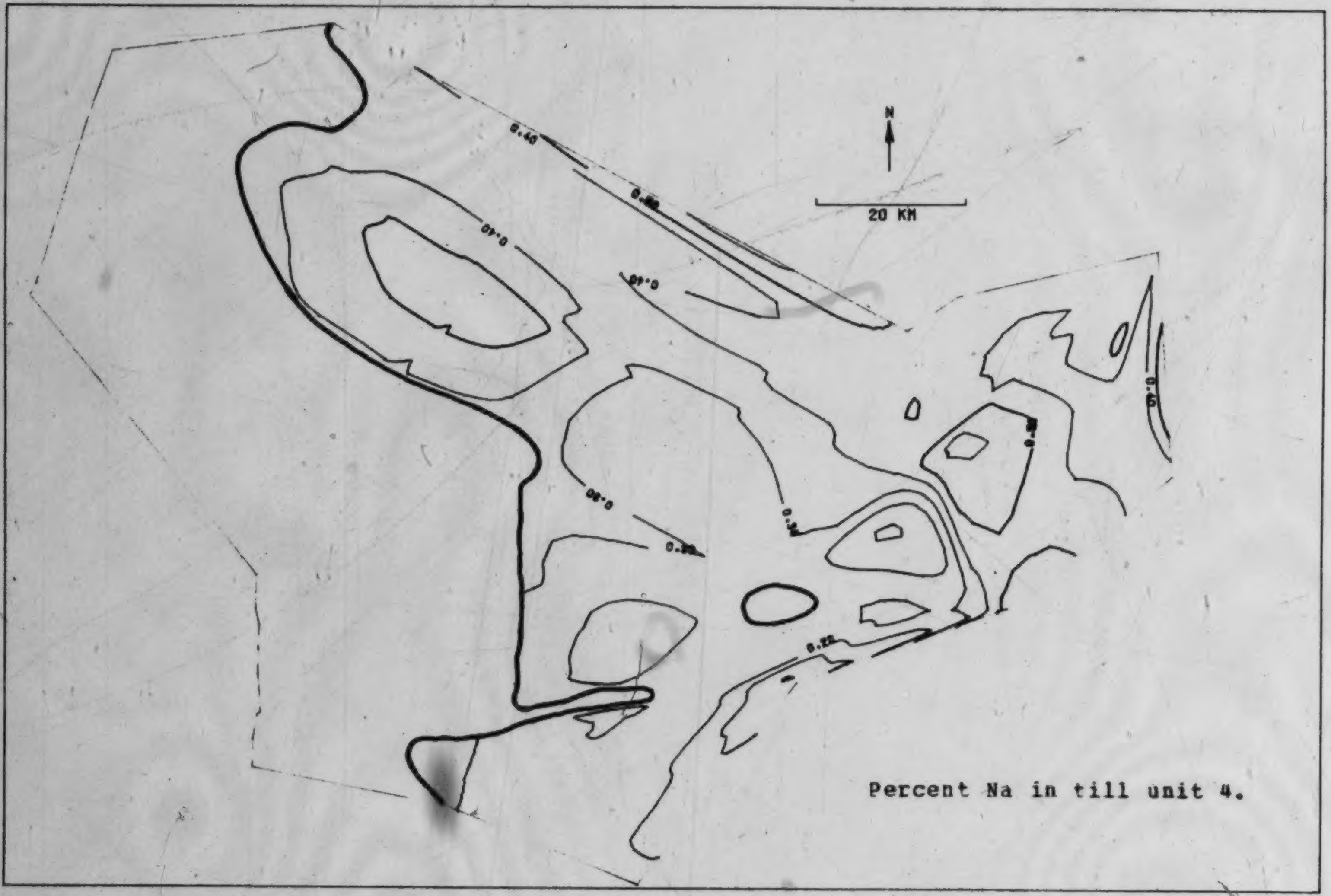
Percent carbonate sand grains in till unit 4.


N
20 KM
22.00
22.00
23.00
22.00

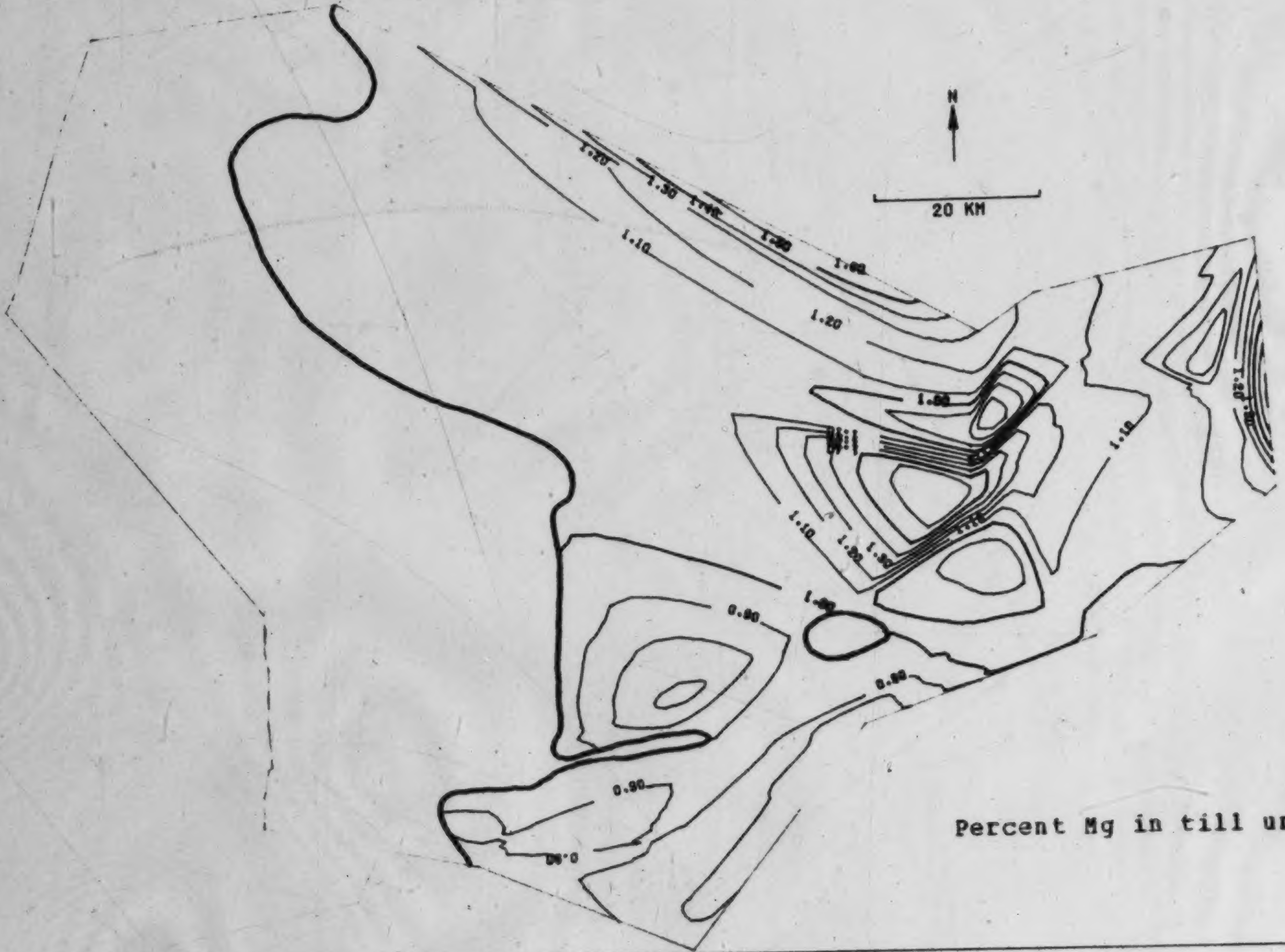
Percent undifferentiated quartz sand grains in till unit 4.


N
20 KM
7.00
8.00
9.00
6.00
5.00
4.50

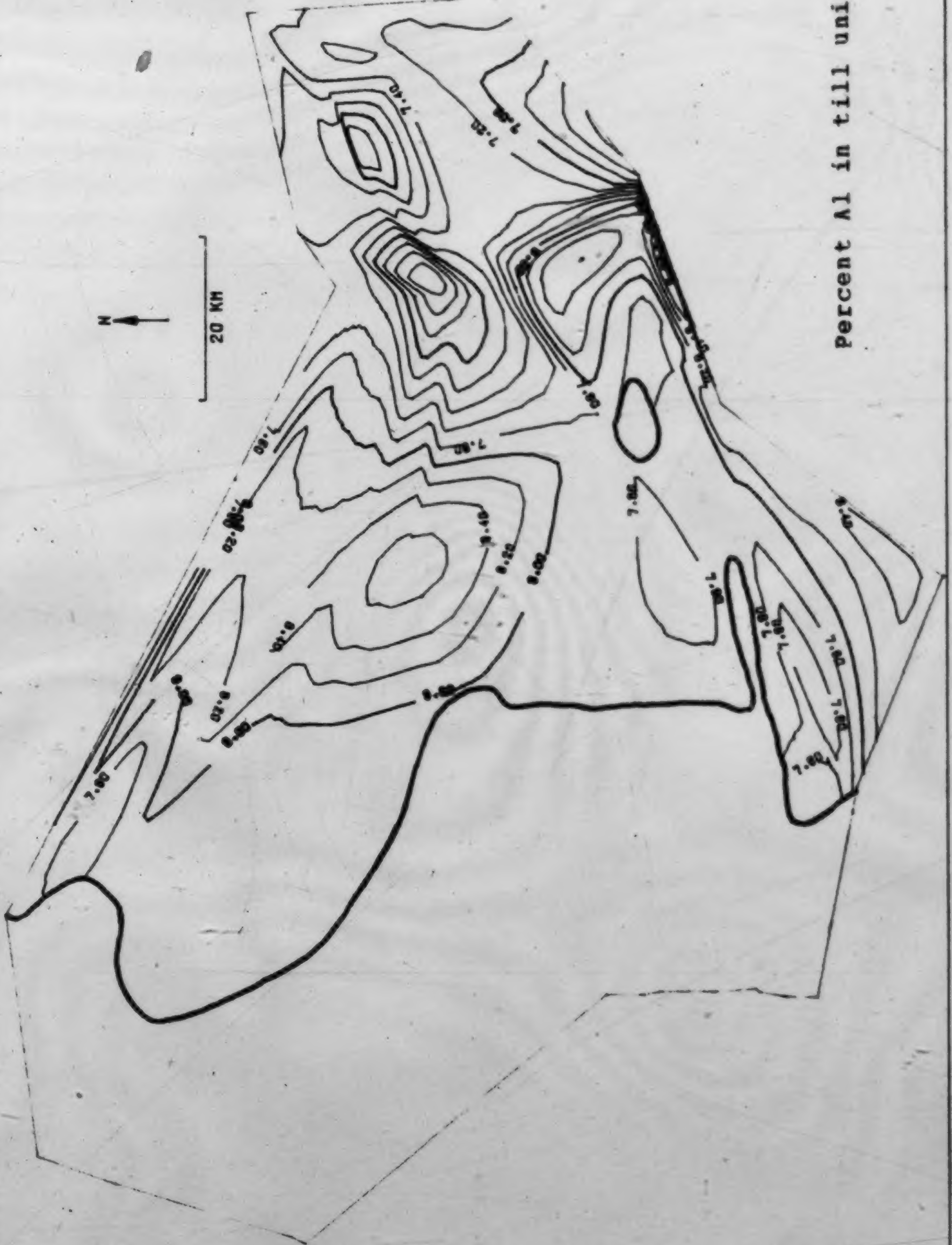
Calcium carbonate equivalent content in till unit 4.


N
20 KM
0.40
0.40
0.40
0.30

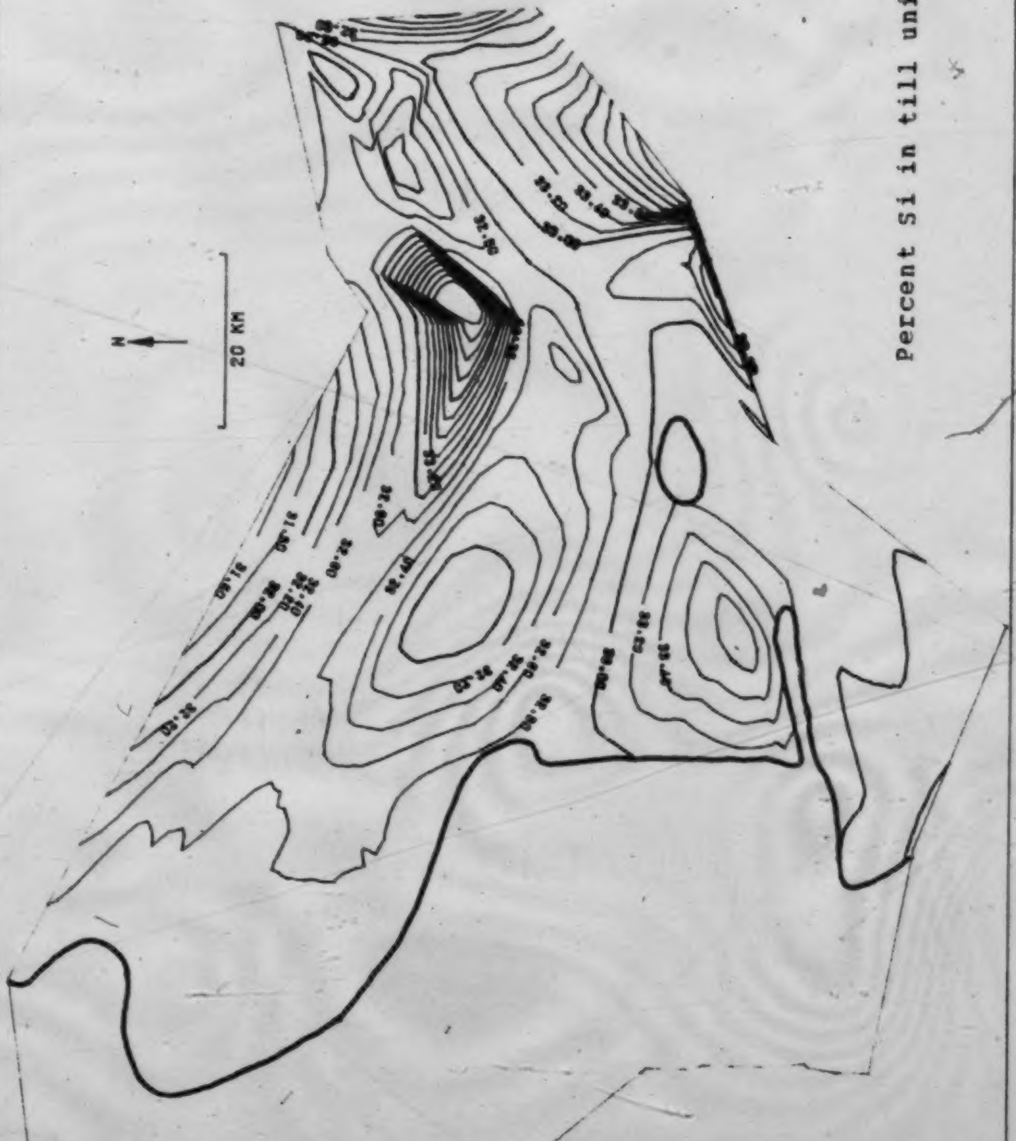
Percent Na in till unit 4.


N
20 KM
1.20
1.30
1.40
1.50
1.60
1.10
1.20
1.50
1.10
1.20
1.30
1.00
1.10
1.20
0.90
0.90
0.90
0.90

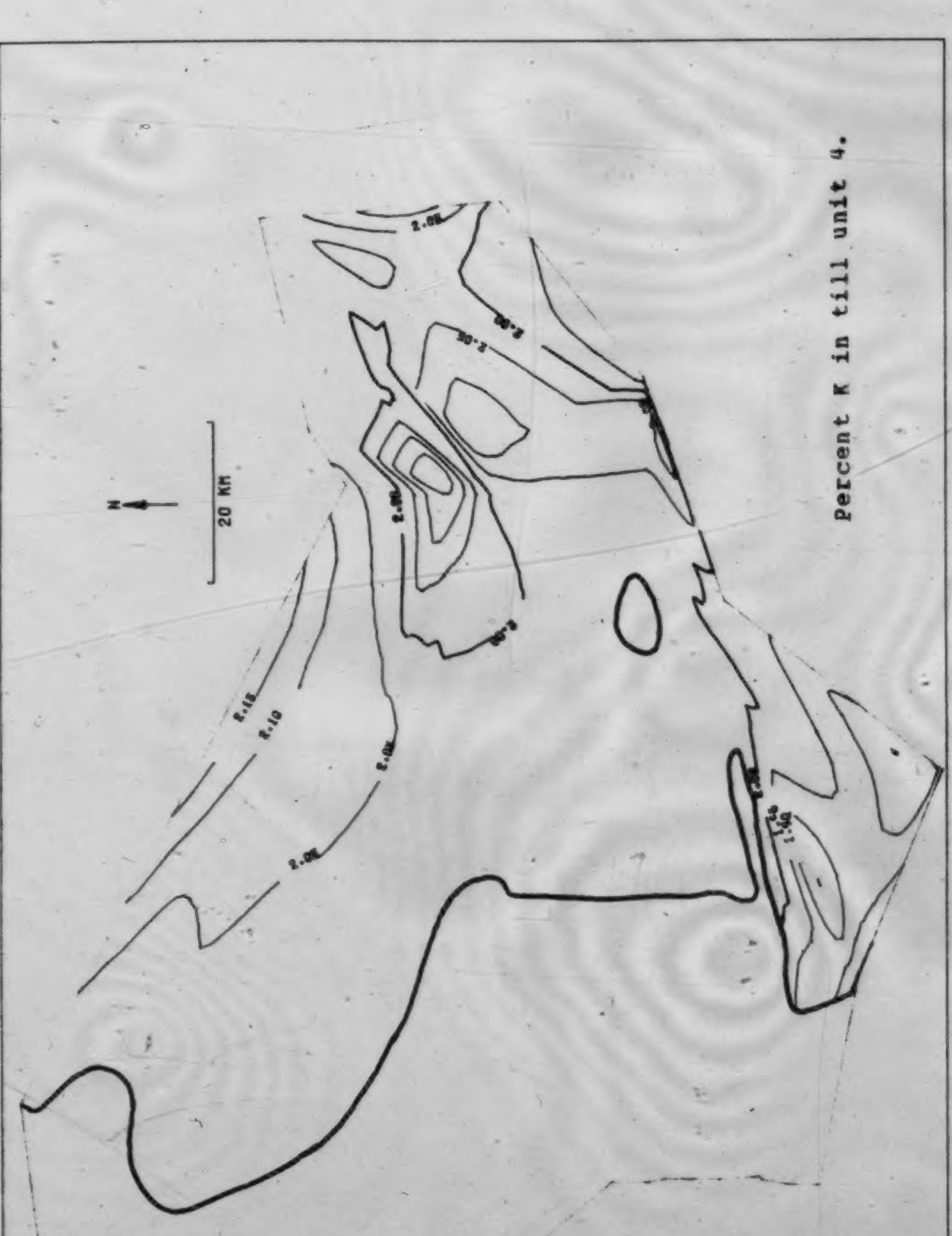
Percent Mg in till unit 4.


N
20 KM
7.40
7.20
7.00
7.60
7.80
8.00
8.20
8.40
8.60

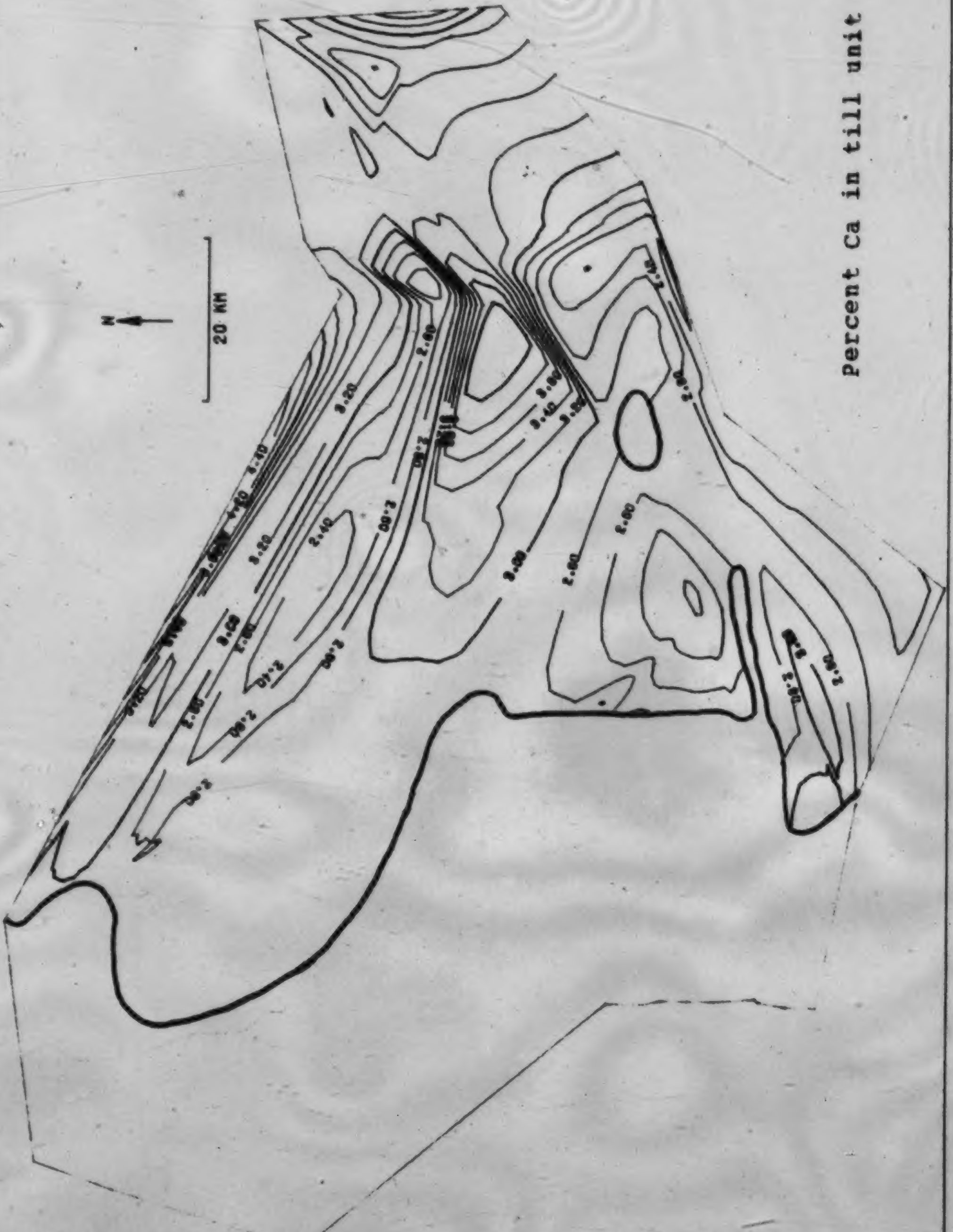
Percent Al in till unit 4.


N
20 KM
32.80
33.00
33.20
33.40
32.40
31.60
32.20

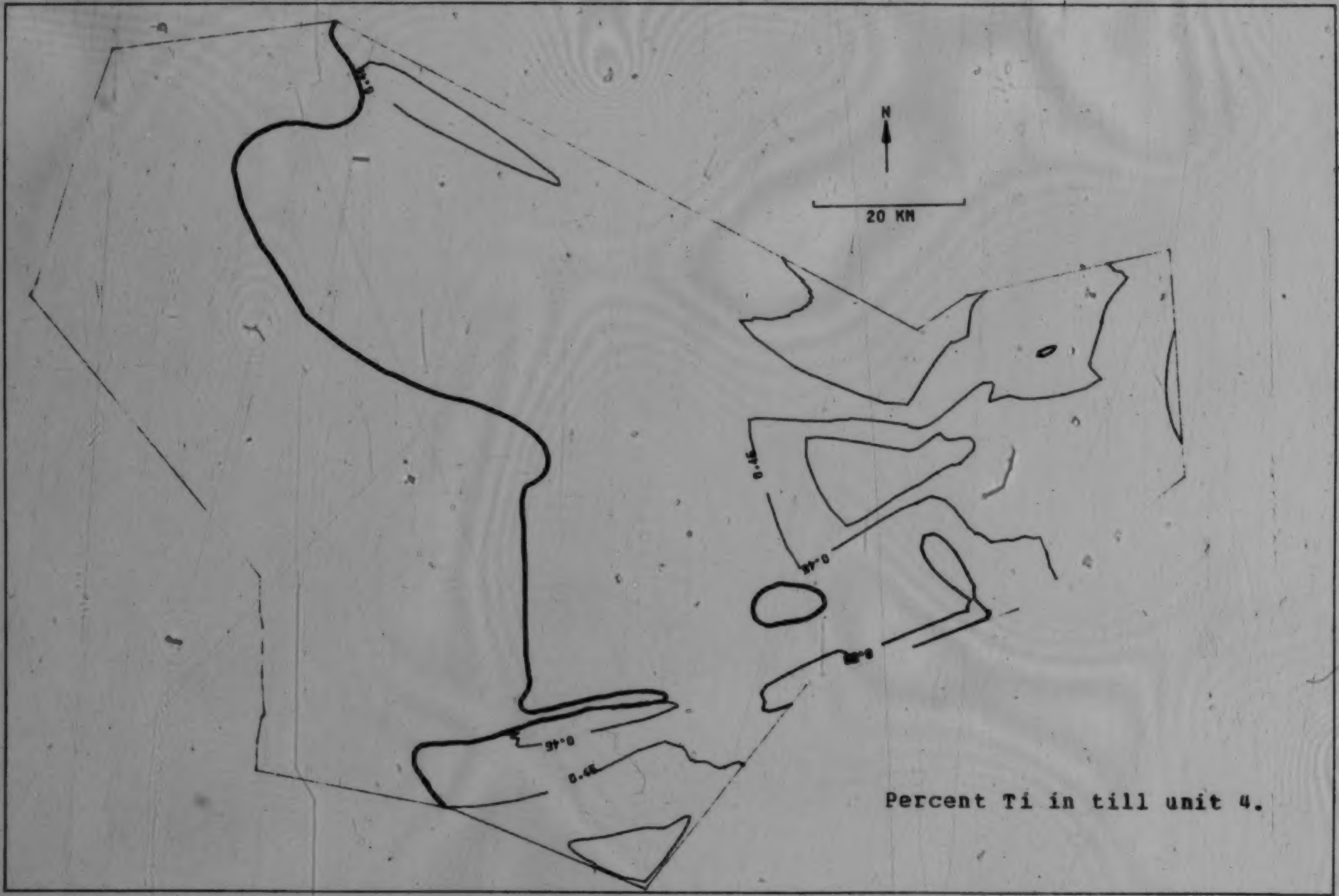
Percent Si in till unit 4.


N
20 KM
2.0%
2.00
2.02
2.0%
2.03
2.15
2.10
2.0%
2.0%
1.46
1.40

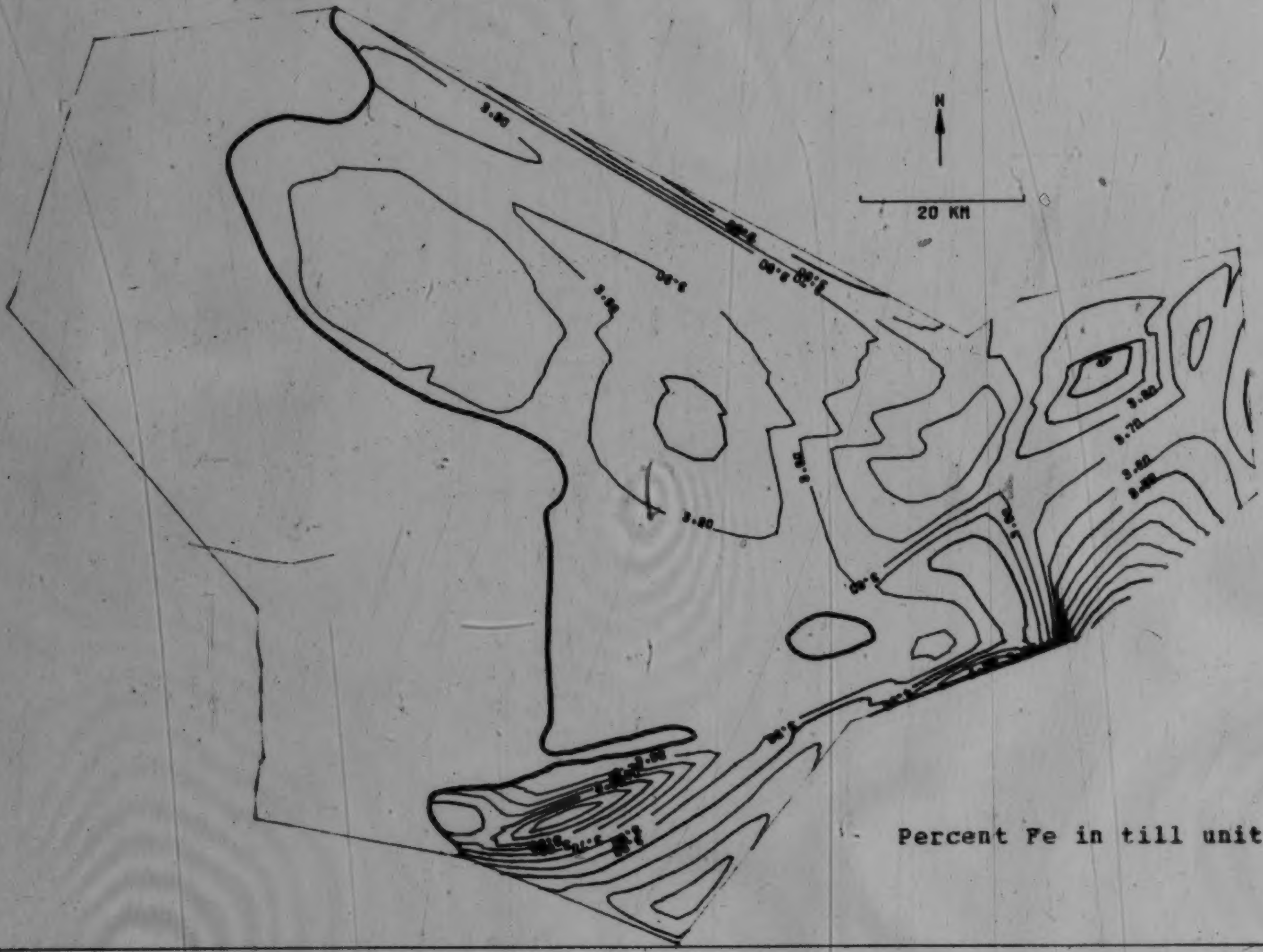
Percent K in till unit 4.


N
20 KM
2.00
2.20
2.40
2.60
2.80
3.00
3.20
3.40

Percent Ca in till unit 4.


N
20 KM
0.46
0.46
0.46

Percent Ti in till unit 4.


N
20 KM
3.80
3.70

Percent Fe in till unit 4.

APPENDIX 8

Between-units versus within-units analysis of variance for each analyzed variable, with statistics describing the variation within each unit.

```
                    VARIABLE  S1020       ANALYSIS OF VARIANCE

         SOURCE                D.F.   SUM OF SQUARES    MEAN SQUARES        F RATIO   F PROB.

BETWEEN UNITS                    2           6.4108          3.2054         4.635     0.0160

WITHIN UNITS                    37          25.5871          0.6915

TOTAL                           39          31.9979



                           STANDARD      STANDARD
GROUP  COUNT        MEAN   DEVIATION       ERROR         MINIMUM       MAXIMUM       95 PCT CONF INT FOR MEAN

Unit 2  19        3.3752      0.7179      0.1647          1.7290        4.6176       3.0292  TO         3.7212
Unit 3  13        2.6166      0.8125      0.2253          1.7614        4.1787       2.1256  TO         3.1076
Unit 4   8        2.5124      1.0948      0.3871          1.2121        4.3533       1.5971  TO         3.4276

Total   40        2.9561      0.9058      0.1432          1.2121        4.6176       2.6664  TO         3.2458
```

```
                    VARIABLE  S2040       ANALYSIS OF VARIANCE

         SOURCE                D.F.   SUM OF SQUARES    MEAN SQUARES        F RATIO   F PROB.

BETWEEN UNITS                    2           3.9570          1.9785         1.820     0.1762

WITHIN UNITS                    37          40.2193          1.0870

TOTAL                           39          44.1763



                           STANDARD      STANDARD
GROUP  COUNT        MEAN   DEVIATION       ERROR         MINIMUM       MAXIMUM       95 PCT CONF INT FOR MEAN

Unit 2  19        4.5696      0.9349      0.2145          3.1437        6.6862       4.1190  TO         5.0201
Unit 3  13        4.6724      1.2309      0.3414          3.4471        7.0878       3.9286  TO         5.4162
Unit 4   8        3.8332      0.9492      0.3356          1.6953        4.5693       3.0396  TO         4.6267

Total   40        4.4557      1.0643      0.1683          1.6953        7.0878       4.1153  TO         4.7961
```

```
            VARIABLE  S4060       ANALYSIS OF VARIANCE

        SOURCE              D.F.   SUM OF SQUARES   MEAN SQUARES      F RATIO   F PROB.
   BETWEEN UNITS              2         5.9926          2.9963         1.126     0.3351
   WITHIN UNITS              37        98.4257          2.6602
   TOTAL                     39       104.4183


                                STANDARD     STANDARD
   GROUP  COUNT        MEAN     DEVIATION      ERROR        MINIMUM      MAXIMUM       95 PCT CONF INT FOR MEAN

   Unit 2   19       7.2818       1.2574       0.2885       4.5444      10.4409       6.6758  TO        7.8879
   Unit 3   13       7.3571       2.2832       0.6332       5.3412      11.7853       5.9774  TO        8.7368
   Unit 4    8       8.2765       1.0288       0.3637       7.0418       9.6826       7.4164  TO        9.1366

   Total    40       7.5052       1.6363       0.2587       4.5444      11.7853       6.9819  TO        8.0285
```

```
            VARIABLE  S60140      ANALYSIS OF VARIANCE

        SOURCE              D.F.   SUM OF SQUARES   MEAN SQUARES      F RATIO   F PROB.
   BETWEEN UNITS              2         3.9410          1.9705         0.313     0.7329
   WITHIN UNITS              37       232.6135          6.2869
   TOTAL                     39       236.5545


                                STANDARD     STANDARD
   GROUP  COUNT        MEAN     DEVIATION      ERROR        MINIMUM      MAXIMUM       95 PCT CONF INT FOR MEAN

   Unit 2   19      11.8355       2.8668       0.6577       8.0010      22.2258      10.4538  TO       13.2172
   Unit 3   13      11.2991       2.5593       0.7098       8.3496      16.3881       9.7526  TO       12.8457
   Unit 4    8      11.0991       0.9322       0.3296      10.0230      12.4416      10.3197  TO       11.8784

   Total    40      11.5139       2.4628       0.3894       8.0010      22.2258      10.7262  TO       12.3015
```

```
                    VARIABLE  S140230      ANALYSIS OF VARIANCE

            SOURCE             D.F.    SUM OF SQUARES    MEAN SQUARES        F RATIO    F PROB.

BETWEEN UNITS                    2           0.4643           0.2322          0.359    0.7010

WITHIN UNITS                    37          23.9442           0.6471

TOTAL                           39          24.4085



                               STANDARD      STANDARD
GROUP   COUNT          MEAN   DEVIATION         ERROR         MINIMUM         MAXIMUM          95 PCT CONF INT FOR MEAN

Unit 2   19          5.1327      0.8237        0.1890          3.1628          6.2025          4.7357  TO          5.5297
Unit 3   13          5.3592      0.9325        0.2586          4.3495          7.3496          4.7957  TO          5.9228
Unit 4    8          5.1216      0.4305        0.1522          4.2522          5.7839          4.7617  TO          5.4816

Total    40          5.2041      0.7911        0.1251          3.1628          7.3456          4.9511  TO          5.4571
```

```
                     VARIABLE  SAND        ANALYSIS OF VARIANCE

            SOURCE             D.F.    SUM OF SQUARES    MEAN SQUARES        F RATIO    F PROB.

BETWEEN UNITS                    2          12.3845           6.1923          0.186    0.8312

WITHIN UNITS                    37        1233.4270          33.3359

TOTAL                           39        1245.8115



                               STANDARD      STANDARD
GROUP   COUNT          MEAN   DEVIATION         ERROR         MINIMUM         MAXIMUM          95 PCT CONF INT FOR MEAN

Unit 2   19         32.1948      5.3981        1.2384         23.7607         50.1730         29.5930  TO         34.7965
Unit 3   13         31.3044      7.5355        2.0900         24.4220         46.7896         26.7507  TO         35.8581
Unit 4    8         30.8428      1.9824        0.7009         28.4426         33.6936         29.1855  TO         32.5001

Total    40         31.6350      5.6519        0.8936         23.7607         50.1730         29.8274  TO         33.4426
```

```
                  VARIABLE  SILT        ANALYSIS OF VARIANCE

        SOURCE             D.F.    SUM OF SQUARES     MEAN SQUARES        F RATIO    F PROB.

BETWEEN UNITS                2            3.5209            1.7605         0.056     0.9454

WITHIN UNITS                37         1157.5150           31.2842

TOTAL                       39         1161.0359



                             STANDARD      STANDARD
GROUP  COUNT        MEAN    DEVIATION        ERROR        MINIMUM       MAXIMUM        95 PCT CONF INT FOR MEAN

Unit 2   19      56.0460       5.1831       1.1891        39.5737       65.1534       53.5478  TO        58.5441
Unit 3   13      56.2724       6.4721       1.7950        44.7264       66.8113       52.3613  TO        60.1834
Unit 4    8      55.4397       4.9468       1.7490        49.5110       61.4109       51.3041  TO        59.5754

Total    40      55.9983       5.4562       0.8627        39.5737       66.8113       54.2533  TO        57.7433

                  VARIABLE  CLAY        ANALYSIS OF VARIANCE

        SOURCE             D.F.    SUM OF SQUARES     MEAN SQUARES        F RATIO    F PROB.

BETWEEN UNITS                2           21.6514           10.8257         1.380     0.2643

WITHIN UNITS                37          290.2926            7.8457

TOTAL                       39          311.9438



                             STANDARD      STANDARD
GROUP  COUNT        MEAN    DEVIATION        ERROR        MINIMUM       MAXIMUM        95 PCT CONF INT FOR MEAN

Unit 2   19      11.7591       1.7639       0.4047         8.9719       14.9542       10.9089  TO        12.6092
Unit 3   13      12.4230       3.4849       0.9666         7.0128       19.3107       10.3171  TO        14.5289
Unit 4    8      13.7174       3.5567       1.2575         9.5811       18.4745       10.7439  TO        16.6909

Total    40      12.3665       2.8282       0.4472         7.0128       19.3107       11.4620  TO        13.2710
```

```
          VARIABLE  LOCAL       ANALYSIS OF VARIANCE

       SOURCE             D.F.   SUM OF SQUARES    MEAN SQUARES       F RATIO   F PROB.
BETWEEN UNITS               2         85.0924          42.5462         4.006    0.0266
WITHIN UNITS               37        393.0085          10.6219
TOTAL                      39        478.1008


                            STANDARD     STANDARD
GROUP  COUNT      MEAN     DEVIATION       ERROR       MINIMUM        MAXIMUM        95 PCT CONF INT FOR MEAN

Unit 2   19     2.7999        2.1328      0.4893        0.0            7.0000        1.7719  TO        3.8279
Unit 3   13     5.7232        3.2010      0.8878        2.0000        13.5000        3.7889  TO        7.6576
Unit 4    8     5.7163        5.1847      1.8331        1.0638        16.5000        1.3818  TO       10.0508

Total    40     4.3333        3.5013      0.5536        0.0           16.5000        3.2135  TO        5.4530
```

```
          VARIABLE  ACID        ANALYSIS OF VARIANCE

       SOURCE             D.F.   SUM OF SQUARES    MEAN SQUARES       F RATIO   F PROB.
BETWEEN UNITS               2        732.1665         366.0830         7.930    0.0014
WITHIN UNITS               37       1708.1632          46.1666
TOTAL                      39       2440.3296


                            STANDARD     STANDARD
GROUP  COUNT      MEAN     DEVIATION       ERROR       MINIMUM        MAXIMUM        95 PCT CONF INT FOR MEAN

Unit 2   19    68.2778        7.4608      1.7116       44.5000        77.0000       64.6818  TO       71.8738
Unit 3   13    59.8943        6.2235      1.7261       51.5000        68.6274       56.1335  TO       63.6552
Unit 4    8    59.4281        5.8728      2.0763       49.0000        67.5000       54.5183  TO       64.3378

Total    40    63.7833        7.9103      1.2507       44.5000        77.0000       61.2534  TO       66.3131
```

```
            VARIABLE  BASIC        ANALYSIS OF VARIANCE

        SOURCE                D.F.    SUM OF SQUARES     MEAN SQUARES          F RATIO    F PROB.

BETWEEN UNITS                  2         45.6126           22.8063           0.557     0.5777

WITHIN UNITS                  37       1515.3630           40.9557

TOTAL                         39       1560.9756


                              STANDARD     STANDARD
GROUP  COUNT        MEAN     DEVIATION       ERROR         MINIMUM        MAXIMUM          95 PCT CONF INT FOR MEAN

Unit 2   19       6.8051       8.6666       1.9883         2.0000        41.0000          2.6279   TO         10.9823
Unit 3   13       4.6493       2.3433       0.6499         1.5000         8.5000          3.2333   TO          6.0653
Unit 4    8       4.6956       3.7317       1.3194         1.0000        11.0000          1.5758   TO          7.8154

Total    40       5.6826       6.3265       1.0003         1.0000        41.0000          3.6592   TO          7.7059
```

```
            VARIABLE  CARB         ANALYSIS OF VARIANCE

        SOURCE                D.F.    SUM OF SQUARES     MEAN SQUARES          F RATIO    F PROB.

BETWEEN UNITS                  2         40.5804           20.2902           5.127     0.0108

WITHIN UNITS                  37        146.4166            3.9572

TOTAL                         39        186.9970


                              STANDARD     STANDARD
GROUP  COUNT        MEAN     DEVIATION       ERROR         MINIMUM        MAXIMUM          95 PCT CONF INT FOR MEAN

Unit 2   19       4.4393       2.2312       0.5119         2.0000         8.5000          3.3639   TO          5.5147
Unit 3   13       4.1063       1.9289       0.5350         0.5000         7.5000          2.9407   TO          5.2719
Unit 4    8       1.8126       1.3182       0.4660         0.0            3.8095          0.7106   TO          2.9146

Total    40       3.8057       2.1897       0.3462         0.0            8.5000          3.1054   TO          4.5060
```

```
                VARIABLE  QTZ      ANALYSIS OF VARIANCE

        SOURCE              D.F.    SUM OF SQUARES     MEAN SQUARES          F RATIO    F PROB.

BETWEEN UNITS                 2        841.9877          420.9937           14.984    0.0000

WITHIN UNITS                 37       1039.5718           28.0965

TOTAL                        39       1881.5593


                              STANDARD      STANDARD
GROUP  COUNT        MEAN     DEVIATION       ERROR          MINIMUM        MAXIMUM          95 PCT CONF INT FOR MEAN

Unit 2  19       17.6778        4.1487       0.9518         10.5000        27.5000         15.6782  TO         19.6774
Unit 3  13       25.6267        5.3441       1.4822         16.5000        34.0000         22.3973  TO         28.8560
Unit 4   8       28.3473        7.4359       2.6290         13.5000        37.5000         22.1308  TO         34.5638

Total   40       22.3951        6.9459       1.0982         10.5000        37.5000         20.1737  TO         24.6165
```

```
                VARIABLE  CACO3      ANALYSIS OF VARIANCE

        SOURCE              D.F.    SUM OF SQUARES     MEAN SQUARES          F RATIO    F PROB.

BETWEEN UNITS                 2        599.3153          299.6575          221.462    0.0000

WITHIN UNITS                 37         50.0643            1.3531

TOTAL                        39        649.3794


                              STANDARD      STANDARD
GROUP  COUNT        MEAN     DEVIATION       ERROR          MINIMUM        MAXIMUM          95 PCT CONF INT FOR MEAN

Unit 2  19       12.6526        1.4975       0.3436         10.7000        16.6000         11.9308  TO         13.3744
Unit 3  13        5.7846        0.6902       0.1914          4.9000         7.0000          5.3675  TO          6.2017
Unit 4   8        3.8000        0.7540       0.2666          2.8000         5.1000          3.1696  TO          4.4304

Total   40        8.6500        4.0805       0.6452          2.8000        16.6000          7.3450  TO          9.9550
```

```
               VARIABLE  NA        ANALYSIS OF VARIANCE

        SOURCE                D.F.    SUM OF SQUARES     MEAN SQUARES        F RATIO    F PROB.

BETWEEN UNITS                   2          0.4044            0.2022           7.782     0.0015

WITHIN UNITS                   37          0.9615            0.0260

TOTAL                          39          1.3659


                                   STANDARD       STANDARD
GROUP  COUNT         MEAN         DEVIATION        ERROR        MINIMUM        MAXIMUM         95 PCT CONF INT FOR MEAN

Unit 2  19         0.2677          0.1966        0.0451         0.0           0.5940          0.1730  TO         0.3625
Unit 3  13         0.1048          0.1386        0.0384         0.0           0.3620          0.0210  TO         0.1885
Unit 4   8         0.0250          0.0707        0.0250         0.0           0.2000         -0.0341  TO         0.0841

Total   40         0.1662          0.1871        0.0296         0.0           0.5940          0.1064  TO         0.2261
```

```
               VARIABLE  MG        ANALYSIS OF VARIANCE

        SOURCE                D.F.    SUM OF SQUARES     MEAN SQUARES        F RATIO    F PROB.

BETWEEN UNITS                   2         10.4643            5.2321         239.223     0.0000

WITHIN UNITS                   37          0.8092            0.0219

TOTAL                          39         11.2735


                                   STANDARD       STANDARD
GROUP  COUNT         MEAN         DEVIATION        ERROR        MINIMUM        MAXIMUM         95 PCT CONF INT FOR MEAN

Unit 2  19         1.8580          0.1747        0.0401         1.6090        2.2940          1.7739  TO         1.9422
Unit 3  13         0.9070          0.1124        0.0312         0.7120        1.1000          0.8390  TO         0.9750
Unit 4   8         0.7340          0.1245        0.0440         0.6030        0.9790          0.6299  TO         0.8381

Total   40         1.3241          0.5376        0.0850         0.6030        2.2940          1.1522  TO         1.4561
```

```
                 VARIABLE  AL        ANALYSIS OF VARIANCE

        SOURCE              D.F.   SUM OF SQUARES    MEAN SQUARES        F RATIO    F PROB.

BETWEEN UNITS                  2           3.7789          1.8894          9.108     0.0006

WITHIN UNITS                  37           7.6754          0.2074

TOTAL                         39          11.4543


                               STANDARD      STANDARD
GROUP   COUNT        MEAN     DEVIATION        ERROR        MINIMUM         MAXIMUM          95 PCT CONF INT FOR MEAN

Unit 2   19        7.6353        0.4702       0.1079         5.9090          8.0410          7.4087   TO          7.8619
Unit 3   13        8.2365        0.5383       0.1493         7.0250          8.7740          7.9112   TO          8.5618
Unit 4    8        8.2726        0.1769       0.0625         7.9270          8.4780          8.1247   TO          8.4205

Total    40        7.9582        0.5419       0.0857         5.9090          8.7740          7.7848   TO          8.1315
```

```
                 VARIABLE  SI        ANALYSIS OF VARIANCE

        SOURCE              D.F.   SUM OF SQUARES    MEAN SQUARES        F RATIO    F PROB.

BETWEEN UNITS                  2          23.3738         11.6869         62.613     0.0000

WITHIN UNITS                  37           6.9062          0.1867

TOTAL                         39          30.2800


                               STANDARD      STANDARD
GROUP   COUNT        MEAN     DEVIATION        ERROR        MINIMUM         MAXIMUM          95 PCT CONF INT FOR MEAN

Unit 2   19       31.4125        0.3413       0.0783        30.9020         32.5930         31.2480   TO         31.5770
Unit 3   13       32.7265        0.5452       0.1512        32.0600         34.2280         32.3970   TO         33.0559
Unit 4    8       33.1990        0.4212       0.1489        32.5930         33.6860         32.8468   TO         33.5511

Total    40       32.1969        0.8811       0.1393        30.9020         34.2280         31.9151   TO         32.4787
```

```
              VARIABLE  K          ANALYSIS OF VARIANCE

        SOURCE                D.F.    SUM OF SQUARES     MEAN SQUARES        F RATIO    F PROB.
    BETWEEN UNITS               2           0.2528             0.1264         15.229     0.0000
    WITHIN UNITS               37           0.3071             0.0093
    TOTAL                      39           0.5599


                            STANDARD       STANDARD
    GROUP  COUNT     MEAN   DEVIATION        ERROR        MINIMUM       MAXIMUM       95 PCT CONF INT FOR MEAN

    Unit 2   19     2.1440     0.1063       0.0244        1.8590        2.2970        2.0927   TO        2.1952
    Unit 3   13     1.9839     0.0724       0.0201        1.8610        2.1140        1.9402   TO        2.0277
    Unit 4    8     1.9862     0.0762       0.0269        1.9100        2.1490        1.9226   TO        2.0499

    Total    40     2.0604     0.1198       0.0189        1.8590        2.2970        2.0221   TO        2.0987

                   ______________________________________

              VARIABLE  CA         ANALYSIS OF VARIANCE

        SOURCE                D.F.    SUM OF SQUARES     MEAN SQUARES        F RATIO    F PROB.
    BETWEEN UNITS               2          40.3753            20.1876        205.358     0.0000
    WITHIN UNITS               37           3.6373             0.0983
    TOTAL                      39          44.0125


                            STANDARD       STANDARD
    GROUP  COUNT     MEAN   DEVIATION        ERROR        MINIMUM       MAXIMUM       95 PCT CONF INT FOR MEAN

    Unit 2   19     4.6227     0.3474       0.0797        4.1690        5.4230        4.4552   TO        4.7901
    Unit 3   13     2.8912     0.2476       0.0687        2.5600        3.3630        2.7416   TO        3.0408
    Unit 4    8     2.2702     0.3227       0.1141        1.9300        2.9020        2.0084   TO        2.5481

    Total    40     3.5911     1.0623       0.1680        1.9300        5.4230        3.2513   TO        3.9308
```

```
                    VARIABLE  TI        ANALYSIS OF VARIANCE

        SOURCE               D.F.    SUM OF SQUARES     MEAN SQUARES          F RATIO    F PROB.

BETWEEN UNITS                  2            0.0843           0.0422          18.605     0.0000

WITHIN UNITS                  37            0.0838           0.0023

TOTAL                         39            0.1682




                            STANDARD      STANDARD
GROUP   COUNT       MEAN   DEVIATION        ERROR        MINIMUM       MAXIMUM        95 PCT CONF INT FOR MEAN

Unit 2   19       0.4038      0.0433       0.0099         0.3350        0.4830        0.3830  TO        0.4247
Unit 3   13       0.4730      0.0419       0.0116         0.3950        0.5400        0.4477  TO        0.4983
Unit 4    8       0.5180      0.0644       0.0228         0.4420        0.6210        0.4641  TO        0.5719

Total    40       0.4491      0.0657       0.0104         0.3350        0.6210        0.4281  TO        0.4702
```

```
                    VARIABLE  FE        ANALYSIS OF VARIANCE

        SOURCE               D.F.    SUM OF SQUARES     MEAN SQUARES          F RATIO    F PROB.

BETWEEN UNITS                  2            0.7204           0.3602           7.268     0.0022

WITHIN UNITS                  37            1.8338           0.0496

TOTAL                         39            2.5542




                            STANDARD      STANDARD
GROUP   COUNT       MEAN   DEVIATION        ERROR        MINIMUM       MAXIMUM        95 PCT CONF INT FOR MEAN

Unit 2   19       3.7473      0.2130       0.0489         2.9830        4.0150        3.6446  TO        3.8499
Unit 3   13       3.9827      0.2408       0.0668         3.5040        4.3810        3.8372  TO        4.1282
Unit 4    8       4.0567      0.2145       0.0758         3.7760        4.3530        3.8775  TO        4.2360

Total    40       3.8857      0.2559       0.0405         2.9830        4.3810        3.8038  TO        3.9675
```

APPENDIX 9

Analysis of variance for each analyzed variable, comparing variation between areas, till units and vertical positions within till units.

The western test area contains drill holes 435E, 436E, $37E and 758E, the central area contains holes 456E, 498E and 709E, while the eastern area contains holes 457E, 458E and 765E.

SOURCE OF S1020 VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARES	F RATIO	PROBABILITY
Between Drill Holes (H)					
Area (A)	6.590	2.	3.295	2.614	0.142
H within A	8.824	7.	1.261		
Within Drill Holes					
Units (U)	3.134	1.	3.134	2.709	0.144
U x A	20.764	2.	10.382	8.974	0.012
U x H within A	8.098	7.	1.157		
Position (P)	2.772	1.	2.772	3.312	0.112
P x A	2.053	2.	1.026	1.226	0.349
P x H within A	5.859	7.	0.837		
U x P	0.113	1.	0.113	0.273	0.617
U x P x A	1.810	2.	0.905	2.188	0.183
U x P x H within A	2.896	7.	0.414		

SOURCE OF S2040 VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARES	F RATIO	PROBABILITY
Between Drill Holes (H)					
Area (A)	4.560	2.	2.280	0.670	0.542
H within A	23.836	7.	3.405		
Within Drill Holes					
Units (U)	9.605	1.	9.605	3.430	0.106
U x A	37.664	2.	18.832	6.725	0.023
U x H within A	19.602	7.	2.800		
Position (P)	10.491	1.	10.491	3.916	0.088
P x A	5.114	2.	2.557	0.955	0.430
P x H within A	18.753	7.	2.679		
U x P	1.346	1.	1.346	0.839	0.390
U x P x A	2.541	2.	1.270	0.792	0.490
U x P x H within A	11.229	7.	1.604		

SOURCE OF S4060 VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARES	F RATIO	PROBABILITY
Between Drill Holes (H)					
Area (A)	8.672	2.	4.336	1.567	0.274
H within A	19.370	7.	2.767		
Within Drill Holes					
Units (U)	13.206	1.	13.206	13.003	0.009
U x A	40.967	2.	20.484	20.169	0.001
U x H within A	7.109	7.	1.016		
Position (P)	0.049	1.	0.049	0.021	0.888
P x A	2.437	2.	1.218	0.529	0.611
P x H within A	16.136	7.	2.305		
U x P	22.601	1.	22.601	6.730	0.036
U x P x A	21.727	2.	10.863	3.235	0.101
U x P x H within A	23.507	7.	3.358		

SOURCE OF S60140 VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARES	F RATIO	PROBABILITY
Between Drill Holes (H)					
Area (A)	34.791	2.	17.396	0.474	0.641
H within A	257.066	7.	36.724		
Within Drill Holes					
Units (U)	12.472	1.	12.472	0.936	0.366
U x A	124.371	2.	62.185	4.667	0.052
U x H within A	93.273	7.	13.325		
Position (P)	4.213	1.	4.213	0.222	0.652
P x A	41.318	2.	20.659	1.089	0.387
P x H within A	132.754	7.	18.965		
U x P	1.674	1.	1.674	0.170	0.692
U x P x A	60.649	2.	30.324	3.087	0.109
U x P x H within A	68.758	7.	9.823		

SOURCE OF S140230 VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARES	F RATIO	PROBABILITY
Between Drill Holes (H)					
Area (A)	40.987	2.	20.493	0.968	0.426
H within A	148.260	7.	21.180		
Within Drill Holes					
Units (U)	19.014	1.	19.014	1.021	0.346
U x A	0.440	2.	0.220	0.012	0.988
U x H within A	130.391	7.	18.627		
Position (P)	4.067	1.	4.067	0.369	0.563
P x A	25.185	2.	12.593	1.142	0.372
P x H within A	77.214	7.	11.031		
U x P	0.003	1.	0.003	0.000	0.988
U x P x A	22.856	2.	11.428	0.851	0.467
U x P x H within A	94.052	7.	13.436		

SOURCE OF SAND VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARES	F RATIO	PROBABILITY
Between Drill Holes (H)					
Area (A)	68.165	2.	34.082	1.275	0.337
H within A	187.141	7.	26.734		
Within Drill Holes					
Units (U)	87.085	1.	87.085	2.858	0.135
U x A	796.104	2.	398.052	13.061	0.004
U x H within A	213.328	7.	30.475		
Position (P)	21.592	1.	21.592	1.664	0.238
P x A	43.607	2.	21.803	1.680	0.254
P x H within A	90.840	7.	12.977		
U x P	25.082	1.	25.082	1.090	0.331
U x P x A	216.920	2.	108.460	4.715	0.050
U x P x H within A	161.031	7.	23.004		

SOURCE OF SILT VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARES	F RATIO	PROBABILITY
Between Drill Holes (H)					
Area (A)	62.259	2.	31.129	0.730	0.515
H within A	298.688	7.	42.670		
Within Drill Holes					
Units (U)	9.320	1.	9.320	2.416	0.164
U x A	309.592	2.	154.796	40.132	0.001
U x H within A	27.000	7.	3.857		
Position (P)	38.697	1.	38.697	4.691	0.067
P x A	33.776	2.	16.888	2.047	0.200
P x H within A	57.750	7.	8.250		
U x P	7.952	1.	7.952	0.293	0.605
U x P x A	31.551	2.	15.776	0.581	0.584
U x P x H within A	190.000	7.	27.143		

SOURCE OF CLAY VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARES	F RATIO	PROBABILITY
Between Drill Holes (H)					
Area (A)	37.410	2.	18.705	0.698	0.529
H within A	187.531	7.	26.790		
Within Drill Holes					
Units (U)	153.364	1.	153.364	7.695	0.028
U x A	112.903	2.	56.452	2.833	0.126
U x H within A	139.508	7.	19.930		
Position (P)	2.476	1.	2.476	0.389	0.553
P x A	36.126	2.	18.063	2.836	0.125
P x H within A	44.578	7.	6.368		
U x P	4.784	1.	4.784	0.633	0.452
U x P x A	88.960	2.	44.480	5.889	0.032
U x P x H within A	52.875	7.	7.554		

SOURCE OF LOCAL VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARES	F RATIO	PROBABILITY
Between Drill Holes (H)					
Area (A)	55.684	2.	27.842	1.909	0.218
H within A	102.102	7.	14.586		
Within Drill Holes					
Units (U)	2.294	1.	2.294	0.121	0.738
U x A	85.319	2.	42.660	2.257	0.175
U x H within A	132.303	7.	18.900		
Position (P)	2.157	1.	2.157	0.116	0.743
P x A	7.871	2.	3.935	0.212	0.814
P x H within A	130.021	7.	18.574		
U x P	1.273	1.	1.273	0.044	0.839
U x P x A	52.329	2.	26.165	0.912	0.445
U x P x H within A	200.749	7.	28.678		

SOURCE OF ACID VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARES	F RATIO	PROBABILITY
Between Drill Holes (H)					
Area (A)	1571.101	2.	785.550	5.474	0.037
H within A	1004.625	7.	143.518		
Within Drill Holes					
Units (U)	3.899	1.	3.899	0.029	0.870
U x A	503.744	2.	251.872	1.874	0.223
U x H within A	941.000	7.	134.429		
Position (P)	65.045	1.	65.045	1.977	0.202
P x A	42.239	2.	21.119	0.642	0.555
P x H within A	230.250	7.	32.893		
U x P	66.822	1.	66.822	0.387	0.554
U x P x A	125.974	2.	62.987	0.364	0.707
U x P x H within A	1210.063	7.	172.866		

SOURCE OF BASIC VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARES	F RATIO	PROBABILITY
Between Drill Holes (H)					
Area (A)	45.955	2.	22.977	0.686	0.535
H within A	234.521	7.	33.503		
Within Drill Holes					
Units (U)	3.675	1.	3.675	0.100	0.761
U x A	49.455	2.	24.727	0.672	0.541
U x H within A	257.764	7.	36.823		
Position (P)	17.139	1.	17.139	0.642	0.449
P x A	71.770	2.	35.885	1.345	0.320
P x H within A	186.738	7.	26.677		
U x P	3.001	1.	3.001	0.065	0.806
U x P x A	49.023	2.	24.512	0.533	0.609
U x P x H within A	322.191	7.	46.027		

SOURCE OF CARB VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARES	F RATIO	PROBABILITY
Between Drill Holes (H)					
Area (A)	1.688	2.	0.844	0.010	0.990
H within A	595.837	7.	85.120		
Within Drill Holes					
Units (U)	3.588	1.	3.588	0.035	0.857
U x A	280.569	2.	140.285	1.358	0.317
U x H within A	723.213	7.	103.316		
Position (P)	22.500	1.	22.500	0.673	0.439
P x A	41.245	2.	20.622	0.617	0.566
P x H within A	233.853	7.	33.408		
U x P	206.041	1.	206.041	6.979	0.033
U x P x A	30.637	2.	15.319	0.519	0.616
U x P x H within A	206.651	7.	29.522		

SOURCE OF QTZ VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARES	F RATIO	PROBABILITY
Between Drill Holes (H)					
Area (A)	770.893	2.	385.447	1.435	0.300
H within A	1879.742	7.	268.534		
Within Drill Holes					
Units (U)	18.243	1.	18.243	0.284	0.611
U x A	242.386	2.	121.193	1.885	0.221
U x H within A	450.008	7.	64.287		
Position (P)	35.911	1.	35.911	0.314	0.593
P x A	1.406	2.	0.703	0.006	0.994
P x H within A	799.754	7.	114.251		
U x P	46.023	1.	46.023	0.457	0.521
U x P x A	22.781	2.	11.391	0.113	0.895
U x P x H within A	704.543	7.	100.649		

SOURCE OF CACO3 VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARES	F RATIO	PROBABILITY
Between Drill Holes (H)					
Area (A)	85.334	2.	42.667	22.532	0.001
H within A	13.255	7.	1.894		
Within Drill Holes					
Units (U)	10.882	1.	10.882	2.094	0.191
U x A	13.203	2.	6.601	1.270	0.338
U x H within A	36.379	7.	5.197		
Position (P)	0.055	1.	0.055	0.047	0.835
P x A	1.282	2.	0.641	0.541	0.605
P x H within A	8.296	7.	1.185		
U x P	1.222	1.	1.222	3.241	0.115
U x P x A	1.923	2.	0.962	2.551	0.147
U x P x H within A	2.639	7.	0.377		

SOURCE OF NA VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARES	F RATIO	PROBABILITY
Between Drill Holes (H)					
Area (A)	0.330	2.	0.165	4.375	0.059
H within A	0.264	7.	0.038		
Within Drill Holes					
Units (U)	0.002	1.	0.002	0.015	0.906
U x A	0.093	2.	0.046	0.370	0.704
U x H within A	0.876	7.	0.125		
Position (P)	0.252	1.	0.252	11.903	0.011
P x A	0.087	2.	0.043	2.049	0.199
P x H within A	0.148	7.	0.021		
U x P	0.013	1.	0.013	0.551	0.482
U x P x A	0.018	2.	0.009	0.381	0.696
U x P x H within A	0.161	7.	0.023		

SOURCE OF MG VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARES	F RATIO	PROBABILITY
Between Drill Holes (H)					
Area (A)	0.763	2.	0.381	2.938	0.118
H within A	0.908	7.	0.130		
Within Drill Holes					
Units (U)	0.308	1.	0.308	3.471	0.105
U x A	0.047	2.	0.023	0.264	0.775
U x H within A	0.621	7.	0.089		
Position (P)	0.190	1.	0.190	3.608	0.099
P x A	0.022	2.	0.011	0.206	0.819
P x H within A	0.369	7.	0.053		
U x P	0.063	1.	0.063	2.682	0.145
U x P x A	0.142	2.	0.071	3.028	0.113
U x P x H within A	0.165	7.	0.024		

SOURCE OF AL VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARES	F RATIO	PROBABILITY
Between Drill Holes (H)					
Area (A)	0.261	2.	0.131	0.409	0.680
H within A	2.239	7.	0.320		
Within Drill Holes					
Units (U)	0.002	1.	0.002	0.010	0.922
U x A	0.618	2.	0.309	1.341	0.321
U x H within A	1.614	7.	0.231		
Position (P)	0.009	1.	0.009	0.122	0.737
P x A	0.222	2.	0.111	1.540	0.279
P x H within A	0.505	7.	0.072		
U x P	0.004	1.	0.004	0.035	0.856
U x P x A	0.682	2.	0.341	3.023	0.113
U x P x H within A	0.790	7.	0.113		

SOURCE OF SI VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARES	F RATIO	PROBABILITY
Between Drill Holes (H)					
Area (A)	4.065	2.	2.033	2.448	0.156
H within A	5.813	7.	0.830		
Within Drill Holes					
Units (U)	0.230	1.	0.230	0.235	0.643
U x A	0.665	2.	0.332	0.339	0.723
U x H within A	6.855	7.	0.979		
Position (P)	1.112	1.	1.112	2.094	0.191
P x A	0.115	2.	0.058	0.108	0.899
P x H within A	3.719	7.	0.531		
U x P	0.217	1.	0.217	0.371	0.562
U x P x A	0.205	2.	0.102	0.174	0.844
U x P x H within A	4.105	7.	0.586		

SOURCE OF K VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARES	F RATIO	PROBABILITY
Between Drill Holes (H)					
Area (A)	0.161	2.	0.080	2.066	0.197
H within A	0.272	7.	0.039		
Within Drill Holes					
Units (U)	0.014	1.	0.014	0.692	0.433
U x A	0.005	2.	0.002	0.120	0.888
U x H within A	0.141	7.	0.020		
Position (P)	0.011	1.	0.011	0.359	0.568
P x A	0.010	2.	0.005	0.167	0.849
P x H within A	0.211	7.	0.030		
U x P	0.000	1.	0.000	0.021	0.888
U x P x A	0.001	2.	0.000	0.020	0.980
U x P x H within A	0.115	7.	0.016		

SOURCE OF CA VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARES	F RATIO	PROBABILITY
Between Drill Holes (H)					
Area (A)	5.185	2.	2.593	7.236	0.020
H within A	2.508	7.	0.358		
Within Drill Holes					
Units (U)	0.180	1.	0.180	0.340	0.578
U x A	0.515	2.	0.258	0.487	0.634
U x H within A	3.700	7.	0.529		
Position (P)	0.522	1.	0.522	1.806	0.221
P x A	0.416	2.	0.208	0.721	0.519
P x H within A	2.022	7.	0.289		
U x P	0.119	1.	0.119	0.740	0.418
U x P x A	0.490	2.	0.245	1.529	0.281
U x P x H within A	1.122	7.	0.160		

SOURCE OF TI VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARES	F RATIO	PROBABILITY
Between Drill Holes (H)					
Area (A)	0.012	2.	0.006	1.715	0.248
H within A	0.025	7.	0.004		
Within Drill Holes					
Units (U)	0.002	1.	0.002	1.137	0.322
U x A	0.009	2.	0.004	2.091	0.194
U x H within A	0.014	7.	0.002		
Position (P)	0.003	1.	0.003	3.063	0.124
P x A	0.001	2.	0.001	0.693	0.531
P x H within A	0.007	7.	0.001		
U x P	0.004	1.	0.004	0.825	0.394
U x P x A	0.020	2.	0.010	2.163	0.186
U x P x H within A	0.032	7.	0.005		

SOURCE OF FE VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARES	F RATIO	PROBABILITY
Between Drill Holes (H)					
Area (A)	0.045	2.	0.023	0.162	0.854
H within A	0.983	7.	0.140		
Within Drill Holes					
Units (U)	0.121	1.	0.121	0.705	0.429
U x A	0.262	2.	0.131	0.761	0.502
U x H within A	1.205	7.	0.172		
Position (P)	0.159	1.	0.159	3.412	0.107
P x A	0.120	2.	0.060	1.287	0.334
P x H within A	0.327	7.	0.047		
U x P	0.014	1.	0.014	0.130	0.729
U x P x A	0.159	2.	0.080	0.737	0.512
U x P x H within A	0.756	7.	0.108		